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EPA RESPONSE TO PUBLIC COMMENTS ON 2017 DRAFT ALUMINUM AMBIENT WATER QUALITY CRITERIA (2020)

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER
OFFICE OF SCIENCE AND TECHNOLOGY
HEALTH AND ECOLOGICAL CRITERIA DIVISION
WASHINGTON, D.C.

TABLE OF CONTENTS

INTRODUCTION

Section 304(a) (l) of the Clean Water Act, 33 U.S.C. § 1314(a)(1), directs the Administrator of the EPA to publish water quality criteria that accurately reflecting the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare that might be expected from the presence of pollutants in any body of water. In support of this mission, the EPA is updating water quality criteria to protect aquatic life from the potential effects of aluminum in freshwater environments. The 2018 aluminum criteria document provides a scientific evaluation of ecological effects and is not a regulation. The recommended limit on the level of aluminum in freshwater that will still be protective of aquatic life depends on a site's water quality parameters. Studies have shown that three water chemistry parameters, pH, dissolved organic carbon (DOC), and total hardness, influence the toxicity of aluminum by affecting the bioavailability of aluminum in the water to aquatic species. Unlike the fixed criteria values in the EPA's 1988 criteria document, the 2018 updated criteria use a Multiple Linear Regression (MLR) model to normalize the toxicity data. The criteria are then generated though a criteria calculator following the 1985 Guidelines calculation procedures based on site pH, DOC, and total hardness levels. This allows users to develop aluminum criteria for fresh waters that appropriately reflect local water chemistry parameters.

The EPA submitted its *Draft Aquatic Life Ambient Water Quality Criteria for Aluminum – 2017* for public comment on July 28, 2017. The request for scientific views on the draft was open for 90 days (60 days plus a 30-day extension). As of October 26, 2017, four hundred and twenty comments from sixty-nine commenters were received (note: one entry was repeated). The EPA considered scientific views from the public on this draft document as well as any new data or information received. This report documents the EPA’s response to public comments on the 2017 draft aluminum criteria document.

The following tables divide the comments into common topics for ease of the reader (e.g., chronic toxicity data, Aluminum Criteria Calculator, mussel toxicity data, etc.). Comments are summarized and the EPA’s responses to the public comments are provided. The EPA completed the 2018 *Final Aquatic Life Ambient Water Quality Criteria for Aluminum* considering these comments and noted in the table where the document was edited, when applicable.

TOPIC 1: Comments regarding acute toxicity data

Comment Number (Organization)	Public Comment on Topic 1: Regarding acute toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of C. dubia and Daphnia magna data from European Aluminium Association 2009*** *The 2009 data from the European Aluminium Association include a series of acute C. dubia tests under varying pH, hardness, and DOC conditions, as well several tests testing the effects of test solution aging on aluminum toxicity.* • *As part of this series of pH, hardness, and DOC manipulation tests, the results for the pH 6, 120 mg/L hardness, 0 mg/L DOC test conditions were not included in Appendix A. The LC50 for this test was 2007.7 µg/L and should be included in the acute dataset unless sufficient reasons are provided.*	The LC_{50} of 2007.7 µg/L was not included because of a poor concentration-response relationship displayed in the raw data so the data was deemed unacceptable for use.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of Ceriodaphnia dubia data from ENSR 1992d*** *ENSR 1992d tested the toxicity of aluminum to C. dubia under four different hardness conditions, 26, 46, 96, and 194 mg/L; all four results were deemed acceptable for criteria derivation.* • *The results from the highest hardness tests were not included in the SMAV derivation because "a more definitive value is available, or value is considered an outlier" (footnote c of Appendix A). This test resulted in an LC50 of >99,600 µg/L. And while this value is higher than any other test, it empirically demonstrates the relative insensitivity of C. dubia under high pH and hardness conditions and high aluminum loadings, conditions which are not well represented by the other acceptable data.* • *Other acute studies, such as from the European Aluminium Association, under comparable high pH and hardness conditions similarly did not demonstrate toxicity. However, the highest aluminum concentrations in those tests were far lower compared to the ENSR study and so the resulting LC50s (e.g., LC50 of >5,000 µg/L at pH 7.88, 120 mg/L hardness, and 0.5 mg/L DOC) carried over into the SMAV calculation may overestimate the toxicity under these conditions.* • *It would be helpful for EPA to provide further discussion on how unbounded tests were deemed acceptable for inclusion in the criteria calculation, per the decision rule*	Thank you for your comment. The results from the highest hardness tests from ENSR (1992d) were included in the final SMAV calculation for *Ceriodaphnia dubia*, as described in the final 2018 criteria document on page 44. Regarding the use of unbounded toxicity values, use of "greater than" values follows the "decision rule" as described in the final aluminum criteria document (Section 3.1), as follows: "greater than" (>) low chronic values and "less than" (<) high chronic values were not used in the calculation of the SMCV; but "less than" (<) low chronic values and a "greater than" (>) high chronic values were included in the SMCV. This approach was also followed for acute SMAV calculations. The methodology is based on the finding that "greater than" values for concentrations of low magnitude, and "less than" values for concentrations of high magnitude do not generally add significant information to the toxicity analysis. In the 2018 Final Aluminum Criteria document in Section 3.1, All Species Mean Acute Value (SMAV) calculations were re-evaluated to verify that they adhere to the decision rule. This approach to the use of "greater than" values was initially described in the 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia in Freshwater and has continued to be applied in subsequent criteria.	Appendix A

Comment Number (Organization)	Public Comment on Topic 1: Regarding acute toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	in Section 3.1.1, and how studies were determined to be outliers. For the ENSR study, it appears the unbounded result decision rule would not apply because this is a ''greater than' high acute value." Inclusion of these pH 8.1 test data would "add significant information" because no toxicity was observed with very high loadings. EPA should provide clarification on whether this decision rule does or does not apply to the lower unbounded LC50s under similar test conditions (e.g., >5000 µg/L). • *This represents a larger issue with the C. dubia acute dataset, where in 23 of the 52 acceptable test results (44%) for the SMAV calculation, an LC50 could not be calculated. This may be problematic because using the Aluminum Criteria Calculator V.1.0 spreadsheet, under most water quality conditions, Ceriodaphnia are one of the four most acutely sensitive genera. However, the test concentrations used to test the sensitivity of C. dubia were insufficient to elicit toxicity in nearly half of the tests, likely overestimating the sensitivity of this species.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Review of the Acute Studies Incorporated into the Draft Criteria* *GEI reviewed the acute toxicity studies that were deemed acceptable by EPA for the purpose of deriving freshwater aquatic life criteria, as presented in Sections 3.1 and Appendix A of the draft criteria document. Our review included comparison of the EC/LC50s endpoints reported in draft criteria document with those found in the original studies, evaluation of whether the inclusion/exclusion of studies were consistent with the 1985 Guidelines, and review of whether the test conditions for each study were accurately reported.* *Number of studies used* *Section 3.1.1 states that the dataset of acceptable acute data includes 118 toxicity tests encompassing 20 freshwater species, representing 18 genera. Within the "Acute Dataset" tab of the spreadsheet included with the criteria document (Aluminum Criteria Calculator V.1.0), only the results of 94 toxicity tests, encompassing 19 freshwater species, representing 18 genera are presented. It is understood that some data that were deemed acceptable were not ultimately included in the Species Mean Acute Value (SMAV) calculation for a number of reasons provided in Sections 3.1 and 5.1 (e.g., results were considered outliers).*	Thank you for your suggestions. Additional rows were added to the Aluminum Criteria Calculator so that the "Acute Dataset" tab will match Appendix A and "Chronic Dataset" tab will match Appendix C. These additional rows were in fact not used in the SMAV/SMCV calculations so they were originally omitted for ease of development of the calculator.	Aluminum Criteria Calculator "Acute Dataset" and "Chronic Dataset" tabs

Comment Number (Organization)	Public Comment on Topic 1: Regarding acute toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Furthermore, we noted some differences in toxicity data between Appendix A in the criteria document, and the "Acute Dataset" tab (also labeled Appendix A) in the Aluminum Criteria Calculator V.1.0 spreadsheet. Some of these differences are discussed further below; we suggest EPA provide additional justification where needed to ensure the acceptable toxicity datasets are consistent and defensible.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of data from Call et al. 1984*** *Not all available data from the Call et al. study were utilized by EPA for the acute database, including:* • *The acute database included toxicity results for snail (Physa sp.), stonefly (Acroneuria sp.), fathead minnow (Pimephales promelas), and green sunfish (Lepomis cyanellus). Rainbow trout (Oncorhynchus mykiss) data were included, but were not used for the SMAV derivation because these were static tests, and flow-through data were available from Gundersen et al. 1994.* • *However, channel catfish (Ictalurus punctatus) and yellow perch (Perca flavescens) data were not included with no explanation provided by EPA for their rejection. The criteria document does mention channel catfish as an example of a recreationally important species and data from this species should be considered for its acceptability.*	The channel catfish and yellow perch test results were not used because each test employed only two exposure concentrations (plus a control), and only six fish per treatment and the data are not acceptable for criteria derivation. These studies and their deficiencies are identified in Appendix J.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*The 2009 study also included a series of seven acute D. magna tests with variable pH and DOC.* • *Six of these studies were deemed acceptable, though only two were included in the SMAV calculation. It is presumed the others were not included because no toxicity was observed and the highest concentrations tested were also relatively low (e.g., 500 µg/L), and thus would qualify as a "'greater than' low acute value" exclusion per Section 3.1.1. If so, further clarification would be helpful.* • *The one LC50 that could be calculated that was retained for SMAV calculation, 795 µg/L, does not correspond to any of the D. magna results we can observe from the original report. In the original study, two tests, both tested at pH 8, 165 mg/L hardness, 0 mg/L DOC, had measurable toxicity, resulting in LC50s of 787.8 µg/L and 720.8 µg/L, respectively. It is unclear whether the LC50 presented in Appendix A refers to either of these studies,*	Use of "greater than" values follows the "decision rule" as described in the final aluminum criteria document (Section 3.1), as follows: "greater than" (>) low chronic values and "less than" (<) high chronic values were not used in the calculation of the SMCV; but "less than" (<) low chronic values and a "greater than" (>) high chronic values were included in the SMCV. This approach was also followed for acute SMAV calculations. The methodology is based on the finding that "greater than" values for concentrations of low magnitude, and "less than" values for concentrations of high magnitude do not generally add significant information to the toxicity analysis. This approach to the use of unbounded values was initially described in the 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia in Freshwater and has continued to be applied in subsequent criteria. All seven studies reported were evaluated. The missing value (720.8 µg/L) displayed a poor concentration-response relationship, so it was deemed unacceptable for use.	Appendix A Appendix K

Comment Number (Organization)	Public Comment on Topic 1: Regarding acute toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	and it is unclear why all seven D. magna tests, rather than just six, were not evaluated for acceptability. • *The D. magna LC50 of 500 µg/L that was included for SMAV derivation should be marked as unbounded (i.e., ">") in the "Acute Dataset" tab of the criteria document spreadsheet.*	The 795 µg/L value is a recalculated value of the author-reported value of 787.8 µg/L. This was recalculated because the raw data reported also indicated a less than optimal concentration-response. The recalculated value (using TRAP) was used instead of the author reported value because it is more appropriate and better fit the empirical data. Thank you for this correction. This was an error and the LC_{50} of 500 µg/L that was included for SMAV in the Aluminum Criteria Calculator was corrected as listed as >500 µg/L.	
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	<u>*Use of C. dubia data from European Aluminium Association 2010*</u> *The 2010 data collected by the European Aluminium Association were for the purpose of evaluating the effects of buffers and the presence of phosphate on aluminum toxicity, to aid in method development for aluminum toxicity exposures. Application of these results for criteria derivation is not recommended in some cases, and no acute LC50s were presented in the original studies.* • *Phosphate was a confounding factor in two of these exposures. Phosphate may competitively bind with aluminum, providing a protective effect against aluminum toxicity to invertebrates. These data should not be included for criteria derivation.* • *The use of synthetic buffers (e.g., HEPES, MES) is important for stabilizing pH over the exposure duration. For example, this study compared to toxicity of two Al test solutions pre-adjusted to pH 6, one using the synthetic buffer of MES (data were not included in Appendix A of the criteria document) and the other using HCl (data were included). In the MES-buffered solution, pH changed at most by 0.02 SU over the duration, while in the HCl adjusted solution, pH changed by over 1.0 SU in each of the test treatments. Indeed, the results of the HCl-adjusted solution in Appendix A, the test condition is listed as 7.08, though the starting pH was <6 in each of the treatments.* • *Given this large potential for pH drift in the unbuffered tests, and its potential effect on aluminum speciation, these results should not be considered for criteria derivation. However, it may be helpful to include a discussion of these patterns elsewhere in the text (e.g., 5.1.1) to further emphasize the importance of pH control*	LC_{50}s were calculated for many of these studies, and where appropriate, included in Appendix A. Tests conducted with a phosphate buffer were removed as you suggested. Thank you for your comment. The EPA agrees that phosphate may competitively bind with aluminum and these data should not be included for criteria derivation. Tests conducted where the exposure solution was not buffered are retained because the pH drift was not well explained for many of studies. In addition, if only pH buffered tests are retained, the database for aluminum criteria development would be very limited. Additional text has been added to the document regarding pH drift during the test exposure.	Section 2.3 Appendix A

Comment Number (Organization)	Public Comment on Topic 1: Regarding acute toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	in the selection of acceptable toxicity tests with aluminum.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of data from Lamb and Bailey 1981, 1983*** *Acute toxicity tests using the midge, Paratanytarsus dissimilis (Lamb and Bailey 1981,1983) were included, but we recommend that EPA reconsider their inclusion for the reasons indicated below.* • *The original report states that after 96 hours, "no apparent effects" were observed, and that "the larvae, including controls, were generally active and they exhibited typical movements and food searching."* • *The endpoint measured after 96 hours is not clearly defined in the original study and no statistics are provided to determine whether any "apparent effects" were statistically significant. We ask EPA to review whether these data are acceptable for inclusion for criteria calculation. The results of study suggest that this species is relatively insensitive to aluminum, and removal of this species would not affect the acute criterion outcome.*	The LC_{50} is a greater than value due to the reasons stated. These are not reasons for exclusion as recommended by the 1985 Guidelines. Use of "greater than" values will follow the approach described in the "decision rule" as described in the 2018 Final Aluminum Criteria document in Section 3.1 as follows: "greater than" (>) low chronic values and "less than" (<) high chronic values were not used in the calculation of the SMCV; but "less than" (<) low chronic values and a "greater than" (>) high chronic values were included in the SMCV (U.S. EPA 2013). This approach was also followed for acute SMAV calculations. This approach to the use of unbounded values was initially described in the 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia in Freshwater and has continued to be applied in subsequent criteria.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of smallmouth bass (Micropterus dolomieui) data from Kane and Rabeni 1987*** *The results from three exposures at pH 5.05, 6.75, and 7.45, respectively, were deemed acceptable to be included in Appendix A. Toxicity was only observed in the pH 5.05 test, and only this result was used as the basis of the SMAV/GMAV calculation.* • *It is presumed that the results from the pH 6.75 and pH 7.45 exposures were not included because they were unbounded and would qualify as a "'greater than' low acute value" exclusion per Section 3.1.1. Confirmation of this exclusion would be helpful.* • *As discussed earlier, we believe it is questionable to use the MLR to normalize data outside the range pH 6 to 8. This is because different forms of aluminum dominate outside this range and the mechanisms of toxicity are likely to differ as well.* • *Under a number of water quality scenarios, smallmouth bass is one the four most acutely sensitive species, and thus the inclusion of the results from this one pH 5.05 study has large effects on the ultimate acute criterion.* • *Given that the acute effects of aluminum for this species have not been well characterized at circumneutral pH, it may be questionable to use this one study to predict*	As the commenter presumed, the *Micropterus dolomieui* test result at pH 7.45 was not used to calculate the SMAV for the species as specified by the "greater than" decision rule (Section 3.1.1). The test result at pH 6.25 is used in the SMAV calculation in the final version of the AWQC. The pH of toxicity test waters for the MLR in the 2018 final document for *Pimephales promelas* toxicity test data ranged 6.0-8.12 for pH. The EPA included some tests beyond these pH values for criteria derivation. The criteria calculator can be also used to address all waters within a pH range of 5.0 to 10.5. This approach was taken so that the recommended criteria can be provided for, and will be protective of, a broader range of U.S. natural waters. Extrapolated criteria values outside of the empirical pH data tend to be lower values and will be more protective of the aquatic environment in situations where pH plays a critical role in aluminum toxicity.	No edits.

Comment Number (Organization)	Public Comment on Topic 1: Regarding acute toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	toxicity over the full range of pH conditions for which the criteria would apply.		

TOPIC 2: Comments regarding alum (aluminum sulfate) used for pollution control

Comment Number (Organization)	Public Comment on Topic 2: Regarding alum (aluminum sulfate) used for pollution control	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	***4. Exclusion for aluminum additions to address high priority Waste Load Allocations*** *Several NPDES permittees are involved in programs that add alum (aluminum sulfate) to receiving waters as part of an "offset" program designed to achieve compliance with TMDL waste load allocations for phosphorus. The alum is used to counteract increased levels of phosphorus, which is often the controlling nutrient. Excess phosphorus can increase algae, impair aesthetics and recreation, create odor problems, and promote the formation of unwanted byproducts during drinking water treatment. Cyanotoxins also may present a significant risk to aquatic organisms. The alum effectively sequesters the reactive mobile phosphorus in the waterways. The following nutrient TMDLs may potentially consider or are using aluminum compounds to control phosphorus.* *[TABLE]* *In the absence of identifiable adverse effects from the addition of alum, we request that the standards provide an explicit exception to the criteria when a significant beneficial use (e.g., nutrient control, protection of drinking water) is achieved by the aluminum addition.*	The EPA's 2018 aluminum criteria provide recommendations for states and authorized tribes to protect aquatic life from potential effects of aluminum. The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards criteria based on or similar to the EPA's recommended criterion. The implementation guidance will describe state flexibilities in implementing the aluminum criteria. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criteria that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available.	No edits.
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	*On March 6, 2017, EPA Region 1 issued a Potable Water Treatment Facility General Permit (PWTF GP) for Massachusetts & New Hampshire. This permit stated that discharge limits for Aluminum would be included in this permit. Many Public Water Systems use alum (aluminum sulfate) as a coagulant in their drinking water treatment process and we feel it will be difficult for them to achieve the current numeric limit while maintaining their current treatment processes. Many of the receiving waters in New England, including many high quality, pristine waterways, already have natural background levels of Aluminum that exceed the current national water quality standard that is used as the basis for numeric permit limits. The high levels of background Aluminum in waters generally considered to be very clean suggest that the current standard is grossly inaccurate and unnecessarily overprotective.* *For Public Water Systems, coagulant changes (such as to iron-based coagulants) could be both a costly and lengthy process*		

Comment Number (Organization)	Public Comment on Topic 2: Regarding alum (aluminum sulfate) used for pollution control	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	which may have significant operational impacts. Public Water Systems that change coagulants to meet Aluminum limits may have problems with other Safe Drinking Water Act requirements; they may have to reassess their lead and copper corrosion control program as one example. In some instances, change in coagulants have resulted in sudden highly elevated lead levels. It simply does not make sense to have Public Water Systems potentially compromising public health, or having to make costly investments to change coagulants or treatment processes, so that they do not exceed an arbitrary water quality standard, which even if exceeded, does not appear to be causing environmental harm in our area. Nor does it make sense for wastewater treatment plants serving communities across the state to spend their limited funds trying to reduce Aluminum in treated discharges with no environmental benefit to be gained. *We have reviewed EPA's proposal and believe that the changes proposed are beneficial and should move forward, however, we do offer the following comments for EPA's consideration before the new criteria is finalized:*		
EPA-HQ-OW-2017-0260-0053 *(Abdul Alkhatib, Director, Massachusetts Water Works Association (MWWA))*	*On March 6, 2017, EPA Region 1 issued a Potable Water Treatment Facility General Permit (PWTF GP) for Massachusetts & New Hampshire. This permit stated that discharge limits for Aluminum would be included in this permit. Many Public Water Systems use alum (aluminum sulfate) as a coagulant in their drinking water treatment process and we feel it will be difficult for them to achieve the current numeric limit while maintaining their current treatment processes. For Public Water Systems, coagulant changes (such as to iron-based coagulants) could be both a costly and lengthy process which may have significant operational impacts. Public Water Systems that change coagulants to meet Aluminum limits may have problems with other Safe Drinking Water Act requirements; they may have to reassess their lead and copper corrosion control program as one example. In some instances, change in coagulants have resulted in sudden highly elevated lead levels. It simply does not make sense to have Public Water Systems potentially compromising public health, or having to make costly investments to change coagulants or treatment processes, so that they do not exceed an arbitrary water quality standard, which even if exceeded, does not appear to be causing environmental harm in our area. Nor does it make sense for wastewater treatment plants serving communities across the state*		

Comment Number (Organization)	Public Comment on Topic 2: Regarding alum (aluminum sulfate) used for pollution control	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	to spend their limited funds trying to reduce Aluminum in treated discharges with no environmental benefit to be gained.		
EPA-HQ-OW-2017-0260-0074 *(Timothy F. Moore, Risk Sciences, on behalf of Lake Elsinore and Canyon Lake Nutrient TMDL Task Force administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA))*	*Thank you for the opportunity to review EPA's Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater (EPA-822-P-17-001) published in July of 2017. The following comments are submitted on behalf of the Lake Elsinore and Canyon Lake Nutrient TMDL Task Force ("Task Force") administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA).* *Lake Elsinore and Canyon Lake are located in western Riverside County, California. Both lakes are on the state's 303(d) list of impaired waters due to excess algae caused by elevated nutrient concentrations. State and federal authorities established a TMDL for these lakes in 2005. The task Force was formed as a collaborative partnership among local stakeholders (principally MS4 permittees, agricultural operators and POTWs) to comply with the TMDL by implementing large-scale water quality improvement projects in the watershed and in the lakes.* *Two of the most effective water quality improvement projects rely on judicious use of aluminum sulfate (aka "Alum") to reduce phosphorus loading in both lakes. The Task Force is deeply concerned that, for reasons described below, the proposed water quality criteria may severely restrict future applications of aluminum-based compounds such as Alum to waters of the U.S. The unintended consequence would be to reduce rather than enhance protection of designated beneficial uses. For this reason the Task Force recommends that the draft criteria be revised to distinguish between beneficial and detrimental forms of aluminum.*		
EPA-HQ-OW-2017-0260-0074 *(Timothy F. Moore, Risk Sciences, on behalf of Lake Elsinore and Canyon Lake Nutrient TMDL Task Force administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA))*	*The Task Force supports the Multiple Linear Regression (MLR) approach that EPA used to develop the draft aluminum criteria and believes it represents a significant improvement over the 304(a) criteria that was promulgated 30 years ago. The MLR adjusts for several water chemistry factors, such as pH, hardness and dissolved organic carbon (DOC), that have been shown to mitigate the potential for aluminum toxicity. However, the model does not yet include a similar adjustment for phosphorus – an equally important mitigating factor that governs the potential toxicity of aluminum.* *Aluminum readily binds with phosphorus to form aluminum*		

Comment Number (Organization)	Public Comment on Topic 2: Regarding alum (aluminum sulfate) used for pollution control	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	phosphate – a fact already acknowledged in the draft criteria document. [Draft Criteria @ pg. 13] This chemical bond occurs quite rapidly and is virtually insoluble (Ksp = 6.3 x 10^{-19}) under natural stream conditions. [Ksp = Solubility Product Coefficient (https://en.wikipedia.org/wiki/Aluminum_phosphate)] When alum is <u>properly applied</u>, the resulting aluminum phosphate molecule is inert and no longer bioavailable. For this reason, alum is increasingly used to minimize phosphorus concentrations in wastewater discharges and, more recently, to mitigate some of the excess phosphorus contributed by the natural sediments in lakes and reservoirs. [Draft Criteria @ pg. 3 and pg. 7] The Task Force uses alum in both ways. *In Canyon Lake, alum is applied to remove and sequester phosphorus from the water column. This program, which has been underway for nearly five years, is expected to help assure compliance with the TMDL targets for phosphorus and chlorophyll-a by the 2020 deadline. Without this program, it is unlikely that Canyon Lake would ever achieve the TMDL targets because lake bottom sediments are, by far, the dominant source of phosphorus to the water column and this phosphorus has a very long half-life (10-15 years). [Anderson, M.A. Technical Memorandum: Estimate Rate at Which Phosphorus is Rendered No Longer Bioavailable in Sediments of Canyon Lake and Lake Elsinore. Dec. 31, 2011] Alum is the only cost effective method for addressing these significant non-point source loads.* *Lake Elsinore is the largest freshwater lake in southern California. Until recently, limited rainfall and natural evaporation caused the lake to dry-up every 25-30 years. Today, approximately 6 mgd of recycled water is added to Lake Elsinore to offset evaporation. Various aluminum-based compounds are used to reduce phosphorus concentrations during the wastewater treatment process. Without these compounds, the recycled water would be unable to comply with the TMDL's wasteload allocation for phosphorus and could no longer be legally discharged to Lake Elsinore. Without recycled water, there is nothing to prevent Lake Elsinore from disappearing completely during the recurring droughts that commonly afflict this area. At such times, all of the designated recreational and aquatic habitat uses will be lost.* *Alum can only be applied in accordance with a NPDES permit.*		

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	[Federal Water Pollution Control Act, §311(et. seq.) and 40 CFR 116.4] The Task Force is concerned that some of the statements made in the draft criteria document may make may make it virtually impossible for state authorities to permit such applications in the future. EPA referenced only one field study on the use of alum to control phosphorus and emphasized that this particular study reported significant adverse effects on invertebrate populations following the alum application.[Draft Criteria @ pg. 63 (referring to Barbiero et al 1988)] This is somewhat misleading because the authors of the study warned that these adverse effects may have been due to the unusual way alum was continuously applied for 35 consecutive days which, in turn, resulted in over-saturation and incomplete complexation. The authors also concluded that: "since continuous application of aluminum sulfate exposes downstream communities to continuous, fresh solutions of aluminum in which polymerization of the hydroxide and complexation with organics are incomplete, the response of affected communities would be expected to differ from those exposed to a single alum application treatment such as a lake treatment." [Barbiero, R., R.E. Carlson, G.D. Cooke & A.W. Beals. The Effects of Continuous Application of Aluminum Sulfate on Lotic Benthic Invertebrates. Lake and Reservoir Management. 4:2 pgs. 63-72 (1988)]		
EPA-HQ-OW-2017-0260-0074 (Timothy F. Moore, Risk Sciences, on behalf of Lake Elsinore and Canyon Lake Nutrient TMDL Task Force administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA))	*In short, the aluminum in alum is a special case and should be treated as such. Perhaps it would be best to regulate alum applications under FIFRA using the registration and labeling tools that EPA purposely designed to balance the risks and benefits of using potentially toxic substances in the environment. Alum is already on the 4B list of "other inert ingredients for which EPA has sufficient information to reasonably conclude that the current pattern of use in pesticide products will not adversely affect public health or the environment." [https://www.epa.gov/pesticide-registration/categorized-lists-inert-ingredients-old-lists]* *Alum has been used to purify drinking water for more than 2,000 years. Today, it is used by thousands of permitted dischargers to enhance wastewater treatment and protect the environment. It is essential that EPA distinguish between the beneficial and detrimental forms of aluminum in order to avoid unintended consequences when the proposed 304(a) criteria is later used to establish state water quality standards and related waste discharge requirements.*		

TOPIC 3: Comments regarding the Aluminum Criteria Calculator

Comment Number (Organization)	Public Comment on Topic 3: Regarding the Aluminum Criteria Calculator	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	*WDEQ/WQD also appreciates the look-up tables provided in Appendix K and the accompanying Aluminum Criteria Calculator V.1.0 spreadsheet used to determine criteria values and taxa sensitivity based on various pH, hardness and DOC values. Though these tools are also helpful, WDEQ/WQD questions whether they can be easily adjusted to delete species/genera in order to facilitate site-specific criteria development. WDEQ/WQD requests that EPA describe how to approach site-specific aluminum criteria using these tools and provide a user manual detailing the various functions and capabilities of the spreadsheet calculator.*	Thank you for your suggestion. The Aluminum Criteria Calculator will still be locked to ensure version control. Please work with your local EPA Region and the EPA Headquarters' staff to develop site-specific criteria values (i.e., add/delete species/genera) on a case-by-case basis, when appropriate. Additionally, another tab will be added to the Aluminum Criteria Calculator that provides instructions.	Aluminum Criteria Calculator new tab entitled "Read Me"
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	*3. EPA has provided states with an interactive aluminum criteria calculator to assist when generating revised aluminum criteria per revised acceptable acute and chronic studies. The calculator's upper limits for pH and hardness result in parameters which extend outside of the model's input capacity to provide the user with modelled output parameters that are certain to be protective. ADEC questions the use of the aluminum criteria calculator when the model will allow the user to enter parameters that extend beyond the range of empirical data used for model development. In addition, ADEC would like EPA to provide further clarification on the certainty of the values found in Appendix K, which provide criteria for various water chemistry conditions that are outside of the model input parameters and how states should justify their use of these parameters for site-specific criteria development.*	Since the draft document was released, additional toxicity test were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria were thus expanded, with details and rationale provided in the criteria document and summarized below. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5. For hardness values, the criteria calculator allows entry of values between 0.01 and 430 mg/L total hardness; criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). For DOC, the criteria calculator will not extrapolate below the lowest empirical DOC of 0.08 mg/L and upper limit of the empirical MLR models will be bounded at a maximum 12.0 mg/L DOC in the criteria calculator; criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L. The pH of toxicity test waters ranged from 6.0-8.7. The EPA has determined that for pH users may extrapolate beyond these values for criteria derivations. The criteria calculator can be used to address all waters within a pH range of 5.0 to 10.5. Thus, criteria values for pH input values beyond the range of the underlying empirical pH data used for model development (pH 6.0 to 8.7) can be generated using the criteria calculator. (This is also reflected in the criteria lookup tables in Appendix K of the 2018 Final Aluminum AWQC document.) The EPA took this approach for pH so that the	Text, tables and MLR equations edited to incorporate new toxicity data throughout the document.

Comment Number (Organization)	Public Comment on Topic 3: Regarding the Aluminum Criteria Calculator	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		recommended criteria are available for protective of a broader range of U.S. natural waters. Extrapolated criteria values outside of the empirical pH data tend to be more protective of the aquatic environment (i.e., lower criteria values) in situations where pH plays a critical role in aluminum toxicity. However, criteria values generated outside of the range of the pH conditions of the toxicity tests underlying the MLR models are more uncertain than values within the pH conditions of the MLR toxicity tests, and thus should be considered carefully and used with caution. The total hardness of toxicity test waters underlying the MLR models ranged from 9.8 to 428 mg/L. Since a decrease in total hardness tends to increase aluminum toxicity, the EPA has determined it is reasonable to extrapolate on the lower bound of the hardness data to enable generation of lower criteria at low hardnesses beyond the limit of the empirical data. Thus, hardness input values in the criteria calculator can be entered that are less than 9.8 mg/L down to a limit of 0.01 mg/L. This is consistent with existing EPA approaches to low end hardness (U.S. EPA 2002). However, criteria values are bounded at the approximate upper limit of the empirical MLR models' underlying hardness data, at a maximum of 430 mg/L total hardness (as $CaCO_3$). The user can input hardness values into the criteria calculator that are greater than 430 mg/L for total hardness, but the criteria magnitude will reach its maximum value at 430 mg/L total hardness (as $CaCO_3$), and criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). This is also consistent with existing EPA guidance on high end hardness "caps" (U.S. EPA 2002). (These total hardness bound approaches are also reflected in the criteria lookup tables in Appendix K of the 2018 Final Aluminum AWQC document.) The EPA took this approach so that the recommended criteria can be provided for, and will be protective of, a broader range of U.S. natural waters. Criteria values generated beyond the lower bound of the hardness conditions of the toxicity tests underlying the MLR models are more uncertain than values within the hardness bounds of the MLR toxicity test data. The DOC of toxicity test waters ranged from 0.08 to 12.3	

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		mg/L. Since most natural waters contain some DOC, the lower bound of the empirical toxicity test data (0.08 mg/L) is the lowest value that can be entered into the criteria calculator; thus no extrapolation below the lowest empirical DOC of 0.08 mg/L is provided. The criteria values generated with the criteria calculator are bounded at the upper limit of the empirical MLR models' underlying DOC data: at 12.0 mg/L DOC. The user can input DOC values greater than 12.0 mg/L into the calculator, but criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L. This is also reflected in the criteria lookup tables in Appendix K of the 2018 Final Aluminum AWQC document. This is consistent with the existing approach for hardness (U.S. EPA 2002) to provide for protection of aquatic organisms through the use of protective, conservative values when water chemistry conditions are beyond the upper limits of the empirical toxicity test data. Please work with your local EPA Region and Headquarters' staff to regarding any refinements sought for situations where water chemistry for a particular water falls outside the bounds of the model.	
EPA-HQ-OW-2017-0260-0062 *(John St. Clair, Rosebud Mining Company)*	*Another concern with the proposed Criteria for Aluminum is the limitations of the Aluminum Criteria Calculator V.1.0.xlsx. The calculator does not allow for hardness, DOC or pH values outside a certain range. It is unclear how the limits for aluminum will be established for water chemistries outside the calculator range. This limitation will directly impact discharges that contain pH variance above 9.0 in impaired streams. Typically pH variance up to 10.0 are given to discharges for the treatment of manganese and in receiving streams with suppressed pH levels due to legacy AMD discharges. While the goal with pH variances is to improve water quality, this benefit may be impacted by restrictions placed on aluminum levels.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. The bounds for pH of the models ranged from 6.0-8.7. The EPA is allowing the user to extrapolate beyond the pH values used to generate the MLR models. The criteria calculator can be used to address all waters within a pH range of 5.0 to 10.5.	Text, tables and MLR equations edited to incorporate new toxicity data throughout the document.
EPA-HQ-OW-2017-0260-0046 *(Jennifer Wigal, Program Manager, Water Quality Standards & Assessments, Oregon Department of Environmental Quality)*	***Implementation*** *Since the criteria values cannot be determined without use of the spreadsheet calculator provided by EPA, it is critical that EPA provide a calculator capable of receiving input for more than 20 sets of the input parameters at a time. States have a need to calculate site-specific criteria values for hundreds of samples when assessing aluminum for Integrated Reporting purposes. A calculator that has room to input at least 500 sets of input samples*	Another tab was added to the Aluminum Criteria Calculator (Over 20 Scenarios). This tab will allow the user to enter input data for 500 samples.	Aluminum Criteria Calculator new tab "Over 20 Scenarios"

Comment Number (Organization)	Public Comment on Topic 3: Regarding the Aluminum Criteria Calculator	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	is needed. DEQ hopes that EPA will make a new calculator incorporating these improvements available as soon as possible. *In conclusion, DEQ agrees that the new 304(a) criteria guidelines and calculator for aluminum is an improvement over the 1988 guidelines. We recognize there is a lack of available data to develop the criteria to more fully reflect diverse environmental conditions and species responses. EPA should seek to expand the boundaries of the model for all parameters with toxicity data that accounts for additional species across a more representative range of the natural water conditions that are likely to be encountered in the states.*		
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Appendix A spreadsheet* *Comment: suggest adding footnote identifier for "a" associated with Method.*	Footnote added to the "Acute Dataset" tab (Appendix A) of the Aluminum Criteria Calculator.	Aluminum Criteria Calculator "Acute Dataset" tab
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Appendix A spreadsheet* *Comment: Add dilution water description to each test, as this data is available from the references.*	Dilution water information was added to the Aluminum Criteria Calculator.	Aluminum Criteria Calculator "Acute Dataset" tab
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Appendix C spreadsheet* *Comment: Add dilution water description to each test, as this data is available from the references.*	Dilution water information was added to the Aluminum Criteria Calculator.	Aluminum Criteria Calculator "Chronic Dataset" tab

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EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Appendix C spreadsheet* *Comment: Please provide references column for each study.*	References were added to the Aluminum Criteria Calculator "Chronic Dataset" tab.	Aluminum Criteria Calculator "Chronic Dataset" tab.
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*(I) The EPA's spreadsheet tool should be revised so that it provides a warning when an input value is outside the MLR range but it should not censor or change such values on its own without additional user-authorization.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development, as noted in the response above. The EPA chose to apply the criteria value bounding approaches selected so that recommended criteria can be provided and that they will be protective of, a broader range of U.S. natural waters.	Text, tables and MLR equations edited to incorporate new toxicity data throughout the document.

Comment Number (Organization)	Public Comment on Topic 3: Regarding the Aluminum Criteria Calculator	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Application of the Criteria from pH 5.0 to 9.0* *A key revision included in the updated criteria is the expansion of the pH range over which the criteria apply. The current Nationally Recommended criteria for aluminum (EPA 1988) apply from 6.5 to 9.0, while the updated criteria extend the range down to pH 5.0. This is significant for several reasons, The Nationally Recommended Water Quality Criteria for pH (EPA 1986) for freshwater is 6.5 to 9. Does it make practical sense to apply any metals criteria to pH values outside the range used in the pH criteria? It may help for EPA to provide additional explanation regarding the regulatory significance of any aluminum criteria outside this pH range to help states determine how to implement these criteria.* *The speciation of aluminum changes considerably from pH 5 to 6, which also affects the mode by which aluminum elicits toxicity to aquatic organisms. At pH 6, insoluble aluminum hydroxides are expected to dominate which may smother gill surfaces thereby limiting respiratory exchange. At pH < 6, dissolved ionic and monomeric species of Al are more abundant, and will affect organisms by a different mechanism by binding to gill tissues and disrupting ionoregulatory function. Furthermore, aluminum solubility increases at pH >8 compared to circumneutral conditions, and the speciation of dissolved aluminum is dominated by the aluminate anion, rather than either cationic forms or neutral hydroxides which dominate a lower pH. The mechanisms of toxicity at these elevated pH levels are less well understood.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria were thus expanded, with details and rationale provided in the criteria document and summarized below. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5.	No edits.

TOPIC 4: Comments regarding aluminum not being a priority pollutant

Comment Number (Organization)	Public Comment on Topic 4: Regarding aluminum not being a priority pollutant	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0036 (Barry N. Burnell, Water Quality Division Administrator, State of Idaho Department of Environmental Quality (DEQ))	*Thank you for the opportunity to provide comments to the EPA on the Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. DEQ understands that while EPA has provided this update, aluminum is not considered a priority pollutant, and that states are not currently required to consider these recommended criteria.*	Thank you for your comments. You are correct that EPA has not identified aluminum as a priority pollutant. However, 40 CFR 131.20 states "…if a State does not adopt new or revised criteria for parameters for which EPA has published new or updated CWA section 304(a) criteria recommendations, then the State shall provide an explanation when it submits the results of its triennial review to the Regional Administrator consistent with CWA section 303(c)(1)…"	No edits.
EPA-HQ-OW-2017-0260-0069 (Julia Young, Water Quality Standards Coordinator, Kansas Department of Health and Environment (KDHE))	*The Kansas Department of Health and Environment, Bureau of Water (KDHE) appreciates the opportunity to comment on the Draft Aquatic Life Ambient Water Quality Criteria for Aluminum 2017 (draft aluminum criteria guidance).* *Comments on Proposed Standards:* *1) KDHE supports the development of criteria using site-specific water chemistry (aluminum, pH, hardness and DOC), because it will allow more realistic criteria limits to be established, than the one-size-fits-all approach of the 1988 aluminum freshwater aquatic life criterion. The fact that adoption is optional and not mandatory because it is not a priority pollutant is also appreciated.*	Thank you for your comments. EPA has not identified aluminum as a priority pollutant, and therefore states are not required to develop state water quality standards for that pollutant. 40 CFR 131 20 states "…if a State does not adopt new or revised criteria for parameters for which EPA has published new or updated CWA section 304(a) criteria recommendations, then the State shall provide an explanation when it submits the results of its triennial review to the Regional Administrator consistent with CWA section 303(c)(1)…"	No edits.
EPA-HQ-OW-2017-0260-0074 (Timothy F. Moore, Risk Sciences, on behalf of Lake Elsinore and Canyon Lake Nutrient TMDL Task Force administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA))	*Finally, the Task Force recommends that EPA add an "Implementation" section to the draft document. This section should note that Aluminum is not a Priority Pollutant metal like those covered by the National Toxic Rule or the California Toxics Rule. It should also explain the range of alternatives available for integrating the proposed 304(a) criteria into state water quality standards, including the option to implement it through existing narrative standards.* *A sub-section of the Implementation chapter should be devoted to a discussion of how to permit the use of alum in the context of TMDL compliance programs. Of particular concern is whether the chronic criteria (CCC) should even be applied to individual alum applications in lakes and reservoirs. Similarly, EPA should carefully consider whether the 1 hour exposure assumption (CMC) or once-in-three-years exceedance interval are appropriate where alum is being used to bind and sequester phosphorus.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The EPA does not include implementation sections in criteria documents, because the criteria recommendations are based strictly on scientific determinations regarding toxicity. The separate implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion.	No edits.

TOPIC 5: Comments regarding BLM Approach

Comment Number (Organization)	Public Comment on Topic 5: Regarding BLM approach	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0020 *(Jon Tack, Chief, Water Quality Bureau, Iowa Department of Natural Resources (DNR))*	*3. BLM Approach* *The draft criteria use regression models to characterize the impact of water chemistry (pH, dissolved organic carbon and hardness) on aluminum toxicity. The Biotic Ligand Model has shown to be the more accurate approach to predict metal toxicity. Iowa suggests that the EPA also provide the BLM model option for states to use.*	The Aluminum AWQC are recommendations. States may choose other scientifically defensible methods to develop aluminum criteria. We do not agree that the BLM is a more accurate approach than a MLR model to predict metal toxicity. Current research indicates that the MLR and Biotic Ligand models have comparable performance in predicting aquatic toxicity for several chemicals, as long as both models are well-constructed and are supported with sufficient data. For example, Brix et al (2017) concluded that the MLR and BLM models' performance for copper were comparable across a wide range of water chemistries and species (Environ. Sci. Technol., 2017, 51(9): 5182-5192). Furthermore, the aluminum BLM we are familiar with does not include all the new available data we have included and has not been finalized at this time.	No edits.

TOPIC 6: Comments regarding chronic toxicity data

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	***<u>Overall Use of the Chronic Database</u>*** *The chronic database is limited and has serious deficiencies. US EPA pretends that the limited chronic database is meaningless, but it directly affects the calculation of the FCV. Moreover, the studies for the three most sensitive species have fundamental flaws and inconsistencies that must be resolved. The normalization of the data based on the MLR is also questionable. To complete the normalization process, US EPA compiled the pH, hardness, and DOC concentrations for the studies in the chronic database. DOC was measured for only thirteen of the twenty-nine chronic values. Of these thirteen, more than half were for C. dubia in the Gensemer study utilized in the development of the MLR, where DOC was held constant at 0.5 ug/l. The overall range of DOC in the chronic database was <0.5 mg/1 to 1.9 mg/1, which is very limited compared to the range of DOC concentrations in the MLR. Even though hardness is known to have a mitigating effect, the highest hardness represented in the chronic database is 220 µg/l for the fathead minnow. Only nine of the twenty-nine chronic values were based on water with hardness ≥100 mg/1, even though many streams have much higher hardness concentrations. US EPA should reconsider the use of the chronic database and determine whether the acute to chronic ratio offers a more reliable chronic criterion.*	The EPA disagrees with the commenter. To clarify how the criteria were developed, EPA notes that there are 2 different aspects of toxicity data supporting the criteria: 1) the MLR data normalization data set used to describe how the bioavailability of aluminum varies across water chemistries; this MLR data set was expanded as noted since the 2017 draft criteria to encompass a wider range of ambient water chemistry conditions, and 2) the sensitivity distribution data, which is the ecotoxicity dataset normalized with the MLR model. These normalized data are then applied in the criteria calculator, following the 1985 Guidelines methods, to determine the criteria for a given set of water chemistry conditions. Normalization of the database with the MLR equations (relative to pH, total hardness and DOC concentrations) utilizes the most current scientific information available for aluminum. Since publication of the draft, additional toxicity tests were conducted with *C. dubia* and *P. promelas*, thereby expanding the water chemistry empirical data used for model development. The MLR models applied in criteria document were developed by an independent expert in the field of modeling metal toxicity and the model was published in a peer-reviewed journal. The most important information for understanding the effects of water chemistry on toxicity is captured via the MLR model's underlying toxicity dataset, not the range of conditions in the toxicity tests used to develop the sensitivity distribution for the criteria calculator. The range of conditions captured through the MLR's underlying toxicity dataset for the 2018 final criteria are: total hardness ranged from 9.8 to 428 mg/L; DOC ranged from 0.08 to 12.3 mg/L; pH of ranged from 6.0-8.7. The current chronic sensitivity distribution database has a sufficient number of diverse studies to support criteria derivation, as recommended by the 1985 Guidelines (8-family MDR satisfied). The 1988 aluminum freshwater chronic dataset included 2 species of invertebrates and one fish species grouped into 3 genera. The 2018 criteria update includes new chronic data for an additional 9 species and consists of 8 invertebrate and 4 fish species grouped into 12	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		genera. With the addition of one study from Appendix H, the Minimum Data Requirements (MDRs) for direct calculation (using a sensitivity distribution, as described in the 1985 Guidelines) of the Final Chronic Value (FCV) were fulfilled. Use of the ACR method over the 8-family MDR approach would introduce more uncertainty to the derived chronic criterion, not less. All toxicity studies used to derive the criteria are scientifically sound. The studies were subjected to a two-level quality review within the EPA, as all studies in criteria documents always are: first, through the ECOTOX database scientific quality screen, and second, through the EPA Office of Water rigorous quality control review as described in the 1985 Guidelines and supporting materials.	
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*Atlantic Salmon and Brook Trout* *The two most sensitive species in the US EPA chronic database are both salmonids, both of which have very limited ranges within the United States. If these two studies are excluded from the chronic database, the FCV increases from 394 µg/l to 816 µg/l even when N (the number of GMCVs in the dataset) is reduced from 12 to 10. Clearly, these two studies strongly affect the calculated criteria.* *The Cleveland brook trout study indicated greater aluminum toxicity at pH 6.55 (Exposure B) than a nearly identical study conducted at pH 5.65 (Exposure A). This directly contradicts the expected results and yielded normalized chronic values that deviated by 1,000 µg/l. Instead of questioning the disparate results, US EPA averaged the two chronic values. The control in Exposure B had higher mortality (10.8%) than most of the test exposures, indicating an independent factor could have affected the results of the study. If the Exposure B results are excluded, then brook trout would no longer be among the four most sensitive species in the chronic database.* *The issue with the Atlantic salmon study is more fundamental. US EPA selected the normalized chronic value for biomass because it is the "most sensitive endpoint." (Draft Aluminum Criteria, Appendix C, footnote d). However, the biomass endpoint was calculated on a wet weight basis. The dry sample weight should have been selected for the biomass endpoint. The toxicity relationship does not exist on a dry weight basis. In fact, the dry*	We disagree that it is scientifically defensible to remove the two most sensitive species from the dataset used to derive the national ambient water quality criteria for aluminum. EPA considers all available reliable data in development of national ambient water quality criteria. The peer-reviewed methodology used to derive the criteria considers data for all aquatic species found across the U.S., not just the two most sensitive species. Further, species included in the sensitivity distribution serve as surrogates for other species in their genera for which chemical-specific toxicity data are not available, due to genetic conservation of important toxicity response traits in species. We disagree in the characterization of the range of the two species (atlantic salmon and brook trout) most sensitive to aluminum as limited in the US. The atlantic salmon is ecologically and commercially important. The brook trout is the state fish of nine US states, including West Virginia. If a state or authorized tribe chooses to modify the criterion to reflect absence of one or more species and all surrogates, then a new criteria value can be derived for relevant waters. Please work with your local EPA Region and Headquarters' staff to develop site-specific criteria that consider any modification of the criteria's toxicity database. The two brook trout studies conducted at pH 5.65 (Exposure A) and pH 6.55 (Exposure B) did yield different normalized	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	weight for the highest exposure concentration was greater than the dry weight of the control sample. If the EC20 survival endpoint is utilized, then Atlantic salmon would no longer be among the four most sensitive species in the chronic database.	EC_{20} effect levels, but some variability is expected in aquatic toxicological studies. We disagree with the assertion that Exposure B results should be excluded from the criteria derivation. In the Cleveland et al. (1989) paper, the maximum control mortality reported for Exposure B was 7.5 percent, which is well below the 20 percent maximum allowed for chronic tests in the 1985 Guidelines; therefore, these results should not be excluded. Because the values are less than 10-fold different, the values were averaged following the 1985 Guidelines methods. We disagree that the dry weight should have been selected for the biomass endpoint. The dry weight data reported by McKee et al. (1989) did not exhibit a dose-response relationship, whereas the wet weight did. The wet weight, therefore, was used to calculate the EC_{20} for the test. And as noted in Appendix C of the document, Buckler et al. (1995) appears to be a republication of McKee et al. (1989),but does not report the most sensitive endpoint and therefore only the most sensitive endpoint (biomass) was used for calculation of the SMCV.	
EPA-HQ-OW-2017-0260-0047 *(Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))*	***Determination of Acceptable Data for Use in Model Development*** *NAMC requests that the results of the Gensemer et al. (2017) seven-day P. promelas tests be included in the chronic toxicity database as these short-term chronic data have been shown to predict reliably early life stage (ELS) chronic toxicity.[Gensemer, R, Gondek J, Rodriquez P, Arbildua JJ, Stubblefield W, Cardwell A, Santore R, Ryan A, Adams W, Nordheim E. (2017). Evaluating the effects of pH, hardness, and dissolved organic carbon on the toxicity of aluminum to freshwater aquatic organisms under circumneutral conditions. Environ Toxicol Chem. Accepted Author Manuscript. doi:10.1002/etc.3920.] Specific studies were performed with aluminum to insure the accuracy of the seven-day studies. This will improve the robustness of the database.*	The 7-day *P. promelas* values will not be included as core chronic data in the sensitivity distribution used to derive the criterion for aluminum because the exposure duration is too short compared to the other tests used in the sensitivity distribution, thus making relative sensitivity difficult to determine. Seven-day chronic tests were used in the MLR normalization studies because they are used solely to characterize the effects of water chemistry on toxicity for the same species, not to evaluate relative taxa sensitivity.	No edits.
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	***Inclusion/Exclusion of data*** *Use of 7-day fathead minnow toxicity tests in chronic database The draft criteria document does not reflect the availability and use of the short-term chronic Pimephales promelas tests conducted under varying pH, hardness, and DOC conditions (Gensemer et al. 2017). Although it is known that longer-term ELS tests are preferred for criteria derivation, short-term chronic data have been shown to reliably predict early-life stage chronic toxicity test*		

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	results for metals (Norberg and Mount 1985, Naddy et al. 2007). Although EPA notes this (page 28), citing DeForest et al. 2017, this was also noted in Gensemer et al. (2017) who presented data from a short-term chronic test in test conditions identical to those used in the Cardwell et al. (2017) P. promelas ELS test. The results are very comparable, with a 7-day biomass EC_{20} of 624.1 (409.8-950.5) µg total Al/L and a biomass EC_{20} of 500.8 (237.2 – 1057.2) µg total Al/L in the ELS test. Based upon both the expansive dataset (pH, hardness, DOC) of short-term chronic tests (Gensemer et al. 2017) which were used in the development of the MLR, we recommend that EPA re-evaluates these studies for possible inclusion to expand the chronic toxicity test database.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of data from Gensemer et al. 2017*** *Chronic data presented in this study summarizes a series of pH, hardness, and DOC manipulation tests for fathead minnow (P. promelas), cladocerans (C. dubia and D. magna) and the green alga (P. subcapitata). These data were used to support the development of the aluminum BLM and the vertebrate and invertebrate MLRs. Some of these studies were already included in the draft criteria document under the name of the testing laboratory (e.g., The Center for the Ecotoxicology and Chemistry of Metals) or sponsor of the research (e.g., European Aluminium Association). However, it does not appear that all available and acceptable data from this study were included in the chronic database, particularly those ultimately published in Gensemer et al. 2017 and DeForest et al. 2017.*	The additional chronic cladoceran studies were added to the final aluminum criteria document. These studies were not included as not all publications were available when the 2017 draft criteria were being developed. However, the 7-day *P. promelas* values will not be included as core chronic data in the sensitivity distribution used to derive the criterion for aluminum because the exposure duration is too short compared to the other tests used in the sensitivity distribution, thus making relative sensitivity difficult to determine.	Appendix C Aluminum Criteria Calculator "Chronic Dataset" tab
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*C. dubia tests, run under varying conditions of pH, hardness, and DOC (also referenced as European Aluminum Association 2010) were found to be unacceptable for inclusion in the chronic database. These data are described in Appendix H as an "Unmeasured chronic exposure" and only NOEC-LOECs are presented. However, total aluminum was indeed measured in these tests. And while EC20s were not calculated in the original laboratory reports, Gensemer et al. 2017 presents the full EC10/20/50s for these chronic studies. The species mean chronic value (SMCV) for C. dubia should, therefore, include these additional data.*	The additional chronic cladoceran studies were added to the final aluminum criteria document. These studies were not included since the publications and associated data were not all available when the 2017 draft criteria were being developed.	Appendix C Aluminum Criteria Calculator "Chronic Dataset" tab

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	***Criteria Development*** *The draft 2017 aluminum criteria updates the 1988 aluminum criteria by incorporating new toxicity data for existing and additional aquatic taxa. To derive the acute and chronic criteria, EPA followed the 1985 Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses (hereafter referred to as "1985 Guidelines"). According to the 1985 Guidelines, acute and chronic criteria are to be derived from toxicological studies that have been screened for acceptable assessment endpoints, measures of effect, study duration and organismal life stage. Though exceptions are presented for specific taxa (e.g., daphnids, cladocerans, salmonids), the 1985 Guidelines reiterate that "the agreement of the data within and between species should be considered."* *WDEQ/WQD has noted several inconsistencies within and between species toxicological data presented in the draft criteria document. For instance, when calculating chronic criteria, EPA selected studies that identified aluminum concentrations at which certain assessment endpoints were observed in 20 percent of test organisms (i.e., EC20). Acceptable assessment endpoints were defined as declines in either biomass, egg numbers, population size, emergence rates and/or survival. WDEQ/WQD is concerned with the use of differing assessment endpoints since each endpoint represents a different aspect of organismal fitness and therefore a different level of aluminum susceptibility. As a result, a considerable amount of uncertainty and/or variability may have been introduced into species and genera mean values and ultimately criteria values. WDEQ/WQD noted similar inconsistencies for other aspects of selected studies, including the chemical salts used, test duration and organismal life stage. WDEQ/WQD recommends that EPA standardize data requirements when possible and elaborate on how data inconsistencies may influence the final recommended criteria.*	The most sensitive endpoint available for each chronic test was used for criteria derivation (although when available, biomass is preferred over growth). Each endpoint selected relates to the organism/species long-term survival, growth, or reproduction. Adverse impacts (reduced fitness) on any of the endpoints used could potentially result in long-term impacts on the species. The 1985 Guidelines does utilize a diversity of chronic test endpoints. The chemical salts used, test duration and organismal life stage all follow EPA Guidelines recommendations.	No edits.
EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	*In addition to meeting data quality standards, the 1985 Guidelines also require that the toxicity data represent eight diverse taxonomic groups. These minimum data requirements (MDRs) ensure that final criteria incorporate varying levels of taxonomic sensitivity within the targeted aquatic community. When developing the draft aluminum criteria, EPA was able to meet the eight MDRs for acute criterion derivation but only seven of the eight MDRs were met for the chronic criterion. EPA decided to use*	The study was not included in Appendix C (acceptable chronic data) because the test pH was only marginally lower than 5 (4.68-4.70). All other test conditions, procedures and results were acceptable for criterion derivation. Satisfying the eight-family MDR to develop the chronic criterion is superior to using the alternate acute to chronic ratio procedure.	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	qualitative information found in a tree frog study to fulfill the remaining chronic MDR (i.e., an additional chordate) despite the study's inability to meet data quality standards. EPA considered the tree frog's inclusion as justified since its toxicity value did not affect the final chronic value.		
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Chronic Toxicity Data* *There are some differences in the chronic Al toxicity data compiled in the draft criteria document and the recent publications by Cardwell et al. (2017) and DeForest et al. (2017). These differences are matters of interpretation and professional judgment, so we are not necessarily recommending that the USEPA adjust any of the toxicity values in the draft criteria document. However, we thought it would be useful to document the basis for these differences.* • *Salvelinus fontinalis (brook trout): The USEPA used two EC20s to define the sensitivity of S. fontinalis to Al: one from a test at pH 5.65 and one from a test at pH 6.55. In Cardwell et al. (2017) and DeForest et al. (2017), only the test at pH 6.55 was used, as the pH 5.65 test was considered to be too low to be appropriate for criteria development. This results in different species mean chronic values (SMCVs) for S. fontinalis.* • *Hyalella azteca (amphipod): The USEPA used two 28-d biomass EC20s to define the sensitivity of H. azteca: one from Cardwell et al. (2017) and one from Wang et al. (2017). In Cardwell et al. (2017), however, the most sensitive endpoint reported was reproduction (based on a 42-d exposure), and in Wang et al. (2017) the most sensitive endpoint was dry weight (based on a 28-d exposure). Cardwell et al. (2017) and DeForest et al. (2017) used the 42-d EC20 based on reproduction to define the sensitivity of H. azteca.* • *Lampsilis siliquoidea (mussel): The USEPA used the biomass EC20 based on Wang et al. (2017), while Cardwell et al. (2017) and DeForest et al. (2017) used the slightly more sensitive mean dry weight endpoint from that study.* • *Lymnaea stagnalis (snail): The USEPA used a 30-d biomass EC20 to define the sensitivity of L. stagnalis, which was independently derived based on data reported in OSU (2012b) and Cardwell et al. (2017). In contrast, Cardwell et al. (2017) and DeForest et al. (2017) used the*	Thank you for noting the differences in the studies that you have highlighted. If aluminum reduced survival and growth, the product of these variables (biomass) was analyzed (when possible), rather than analyzing them separately as in USEPA 2013 recommendations (United States Environmental Protection Agency. 2013. Aquatic life ambient water quality criteria for ammonia – freshwater. EPA-822-R-13-001. Office of Water, Washington, DC). Biomass addresses both survival and growth impacts simultaneously. The rationale for each endpoint selected is detailed in the final aluminum criteria document.	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	30-d EC20 based on wet weight, the most sensitive reported endpoint in that study, to define the sensitivity of L. stagnalis. We recommend that the basis for USEPA's biomass endpoint calculation be provided since that is not available from the original study report (OSU 2012b) and paper (Cardwell et al. 2017). • *As a general comment, which relates to several of the species-specific decisions above, the USEPA states that the biomass endpoint was used to define the sensitivities of species where tests included both the survival and growth endpoints, rather than using the most sensitive endpoint. Their rationale was for consistency with the criteria for ammonia (USEPA 2013). However, the basis for this decision is not apparent in the 2013 ammonia document. We suggest USEPA provide clarification or a basis for using an endpoint other than the most sensitive.*		
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Gensemer et al. 2017 – 21-day Daphnia magna chronic test Appendix H of the document states that the 21-day D. magna chronic test reported in Gensemer et al. (2017) was excluded because of unmeasured chronic exposures. This is incorrect, both total measured Al and* EC_{20}*s based on the measured values are reported in the publication. This toxicity test should be included in the chronic database.*	The additional chronic cladoceran study was added to the document.	Appendix C Aluminum Criteria Calculator "Chronic Dataset" tab
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Determination of acceptable data for use in model development*** *The Association notes that there are several discrepancies in the selection of study data that was used by EPA to develop both the acute and chronic MLR models. These are more specifically detailed in the appended GEI letter report, and need to be addressed by the EPA prior to finalizing updated aluminum criteria. In particular, the Association requests that the results of the Gensemer et al. (2017) 7-day P. promelas tests be included in the chronic toxicity database as this short term chronic data has been shown to reliably predict early life stage (ELS) chronic toxicity. This will improve the scientific accuracy and reliability of the database.*	The 7-day *P. promelas* values will not be included as core chronic data in the sensitivity distribution used to derive the criterion for aluminum because the exposure duration is too short, thus making relative sensitivity difficult to determine.	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Review of the Chronic Studies Incorporated into the Draft Criteria*** *GEI reviewed the chronic toxicity studies that were deemed acceptable by EPA for the purpose of deriving freshwater aquatic life criteria, as presented in Sections 3.2 and Appendix C of the draft criteria document.* ***General*** *The table presented in the "Chronic Dataset" tab of the Aluminum Criteria Calculator spreadsheet of the criteria document, titled "Appendix C. Acceptable Chronic Toxicity Data of Aluminum to Freshwater Aquatic Animals", does not include a column for references. To aid the reader in understanding the source of the data retained for the chronic criteria derivation, EPA should review the database included in this spreadsheet to ensure all the studies are properly referenced, and then provide the references in the final version of the Aluminum Criteria Calculator spreadsheet.*	The database was reviewed and references were added to the "Chronic Dataset" tab (Appendix C) of the Aluminum Criteria Calculator.	Aluminum Criteria Calculator "Chronic Dataset" tab
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of data from OSU 2012*** *A number of vertebrate and invertebrate toxicity studies were conducted by Oregon State University (and published in Cardwell et al. 2017) to help address data gaps for ecotoxicity for freshwater species under circumneutral conditions.* • *The EC20 result for great pond snail (Lymnaea stagnalis) are presented in the draft criteria document as 745.7 µg/L for biomass. These data, as published by Cardwell et al., only assessed snail survival and wet weight, with a reported EC20 of 1148.5 µg/L for wet weight. EPA should clarify why an endpoint different than what was reported in the original studies was used and how the EC20 for this endpoint was derived.*	The endpoint reported in Cardwell et al. (2017) was wet weight of the great pond snail, *Lymnaea stagnalis*. However, the EPA used biomass as the endpoint. If aluminum reduced survival and growth, the product of these variables (biomass) was analyzed (when possible), rather than analyzing them separately. The biomass endpoint was used when available if growth effects were the most sensitive. This approach is as per USEPA 2013 (U.S. EPA (United States Environmental Protection Agency). 2013. Aquatic life ambient water quality criteria for ammonia – freshwater. EPA-822-R-13-001. Office of Water, Washington, DC). For purposes of consistency in calculating the biomass endpoint, the *Lymnaea stagnalis* data from Table 3-8 of OSU 2012b were used to calculate the biomass using EPA's TRAP program.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of data from Wang et al. 2017*** *Wang et al. presented the chronic toxicity results for mussel (Lampsilis siliquoidea) and amphipod (Hyalella azteca).* • *The EC20 presented in the draft criteria document for mussel, 169 µg/L, differs from the EC20 of 163 µg/L as published in the original study. The chronic database should be updated to reflect this.*	The EC_{20} of 169 µg/L is the biomass reported in the study. The EC_{20} of 163 µg/L is for dry weight. Biomass was chosen over growth endpoints for chronic values. If aluminum reduced survival and growth, the product of these variables (biomass) was analyzed (when possible), rather than analyzing them separately. The biomass endpoint was used when available if growth effects were the most sensitive.	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	• *Short-term chronic (i.e., 7-day) P. promelas tests conducted under varying pH, hardness, and DOC conditions were also not included. While early-life stage tests for P. promelas are preferred for criteria derivation, short-term chronic data have been shown to reliably predict early-life stage chronic toxicity (Norberg and Mount 1985, Naddy et al. 2007). EPA noted this similarity on page 28, citing DeForest et al. 2017, but we also noted this similarity in Gensemer et al. 2017. One of the test conditions in a short-term chronic P. promelas test presented by Gensemer et al. (2017), pH 6, 120 mg/L hardness, and 0 mg/L DOC, were identical to the test conditions used in the 33-d early-life stage test conducted by Cardwell et al. 2017 (included in Appendix C of the criteria document). The results between these two studies were comparable, with EC20s (and 95% CI) for the biomass endpoint of 624.1 (409.8-950.5) µg/L in the 7-day test and 500.8 (237.2 – 1057.2) µg/L in the early-life stage test.* *To help illustrate the similarity of the 7-day and ELS P. promelas tests, we used the MLR to normalize all of the 7-day test results, and recalculate the GMCV under for different water quality conditions with the data included (Table 1).* *[Table 1]* *Not surprisingly, the recalculated GMCVs were extremely similar (only ca. 2% different) to GMCVs calculated in the draft EPA criteria (Table 1). Therefore, we recommend that all of short-term chronic results from Gensemer et al. (2017) should be evaluated and considered for the possible inclusion to improve the scientific reliability of the chronic toxicity database.*	The 7-day *P. promelas* values will not be included as core chronic data in the sensitivity distribution used to derive the criterion for aluminum because the exposure duration is too short, thus making relative sensitivity difficult to determine.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*A 21-day D. magna chronic test was also reported in Gensemer et al. (2017) that should be considered in the chronic database. While Appendix H described this test as an "Unmeasured chronic exposure," total aluminum was measured and EC20s were reported in Gensemer et al. 2017.*	The additional chronic cladoceran study was added to the document and the study was cited as Gensemer et al. 2018 (in addition to the European Aluminum Association 2010 citation).	Appendix C Aluminum Criteria Calculator "Chronic Dataset" tab

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Use of data from McCauley et al. 1986*** • *Of the two chronic C. dubia results presented in Appendix C, the EC20s could only be calculated for one of these. The other is reported as a maximum allowable toxicant concentration (MATC) of <1,100 µg/L. In the original report, the MATC for this test is estimated as 1600 µg/L. EPA should provide explanation for this difference, though this will not affect the resulting criteria as this result was not retained for SMCV calculation.*	An EC_{20} could only be calculated for the Lake Superior water test. The UW lab-water test missed the endpoint (no treatment with insignificant effects). Thus, an EC_{20} is not available for this test (neither TRAP model EC_{20} is recommended for this test).	No edits.
EPA-HQ-OW-2017-0260-0056 *(Chris Burbage, Ph.D., Environmental Scientist, Hampton Roads Sanitation District (HRSD), Virginia Beach, VA)*	***Comment 5: Use of non-native invasive vertebrate in calculation of chronic criteria****.* *HRSD requests that EPA omit toxicity data related to the vertebrate Zebrafish (Danio rerio) in the calculation of the aluminum chronic freshwater criteria.* *HRSD supports the intent of the 1985 AWQC Guidelines to the use of data representing the diversity of species found in the United States, because a diverse group of test subjects is more representative of ecosystems as a whole. The addition of a non-native vertebrate species in the calculation of the aluminum chronic criteria, though helpful in meeting MDRs, is unacceptable. HRSD requests documentation confirming the naturally occurring geographic distribution of D. rerio in the continental United States, and hence, justification of the use of data for this species in the calculation of the freshwater aluminum chronic criteria. If D. rerio is in fact a non-native species HRSD requests that its use in the calculation of the above stated chronic criteria be justified or removed from the Final Chronic Value database.* *[Cited References]*	The USEPA determined it was appropriate to include the zebrafish (*Danio rerio*) in the acceptable chronic toxicity database. While the zebrafish was originally non-native, zebrafish populations are now established and reproducing in the United States. See USGS fact sheet: https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=504 In addition, zebrafish is a commonly used test species that provides information for other non-tested organisms. Zebrafish are used to fulfill the “second fish family” requirement for aluminum per the 1985 guidelines minimum data requirements. It serves as a representative for other, numerous, untested fish species in the U.S. Further, zebrafish was ranked 6^{th} in sensitivity in the 2018 aluminum chronic data set, thus its chronic value is not included in the numeric criteria calculations, but is included only in the “N,” count of the number of genera in the data set. Inclusion of zebrafish for surrogacy increases criteria values by increasing the “N” in the criteria calculation denominator. Finally, zebrafish are included in analyses in other EPA programs, e.g., Office of Pesticide Programs, for the purposes of including all available quality data to serve as surrogates, given the sparseness of data relative to the number of untested species in U.S. waters. Inclusion in the aluminum criteria is consistent with this practice.	No edits.

Comment Number (Organization)	Public Comment on Topic 6: Regarding chronic toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*One of the most sensitive species tested, zebrafish (Danio rerio) are not native to North America, yet were included in the acceptable chronic toxicity database. While zebrafish are an invaluable model organism for ecotoxicological studies, they may not represent the sensitivity of native fishes to aluminum as recommended in the 1985 Guidelines. EPA should either reconsider including this species, or provide justification for their inclusion as the results from this species may have a large impact on the resulting chronic criterion.*	The USEPA determined it was appropriate to include the zebrafish (*Danio rerio*) in the acceptable chronic toxicity database. While the zebrafish was originally non-native, zebrafish populations are now established and reproducing in the United States. See USGS fact sheet: https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=504 In addition, zebrafish is a commonly used test species that provides information for other non-tested organisms. Zebrafish are used to fulfill the "second fish family" requirement for aluminum per the 1985 guidelines minimum data requirements. It serves as a representative for other, numerous, untested fish species in the U.S. Further, zebrafish was ranked 6th in sensitivity in the 2018 aluminum chronic data set, thus its chronic value is not included in the numeric criteria calculations, but is included only in the "N," count of the number of genera in the data set. Inclusion of zebrafish for surrogacy increases criteria values by increasing the "N" in the criteria calculation denominator. Finally, zebrafish are included in analyses in other EPA programs, e.g., Office of Pesticide Programs, for the purposes of including all available quality data to serve as surrogates, given the sparseness of data relative to the number of untested species in U.S. waters. Inclusion in the aluminum criteria is consistent with this practice.	No edits.

TOPIC 7: Comments regarding compliments to Aluminum AWQC development

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0008 *(F. Paul Calamita, Chairman, AquaLaw PLC on behalf of North Carolina Water Quality Association et al.)*	*JOINT COMMENTS OF THE NORTH CAROLINA WATER QUALITY ASSOCIATION, SOUTH CAROLINA WATER QUALITY ASSOCIATION, WEST VIRGINIA MUNICIPAL WATER QUALITY ASSOCIATION, ASSOCIATION OF MISSOURI CLEANWATER AGENCIES REGARDING THE DRAFT UPDATED AQUATIC LIFE AMBIENT WATER QUALITY CRITERIA FOR ALUMINUM IN FRESHWATER* *Please accept the following comments on the Environmental Protection Agency's (EPA's) draft updated aquatic life ambient water quality criteria for aluminum in freshwater ("Aluminum Criteria"), Docket No. EPA-HQ-OW-2017-0260, on behalf of the North Carolina Water Quality Association, South Carolina Water Quality Association, West Virginia Municipal Water Quality Association, and Association of Missouri Clean Water Agencies.* *The North Carolina Water Quality Association, South Carolina Water Quality Association, West Virginia Municipal Water Quality Association, and Association of Missouri Clean Water Agencies are incorporated associations of owners and operators of Publically Owned Treatment Works throughout their respective states.* *All of the members of these four associations appreciate EPA's efforts to develop updated aluminum criteria. It is critically important to POTWs that applicable water quality criteria accurately reflect the water quality goals for which they are designed without being unnecessarily stringent.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0008 *(F. Paul Calamita, Chairman, AquaLaw PLC on behalf of North Carolina Water Quality Association et al.)*	*Our joint comments on EPA's draft Aluminum Criteria are as follows:* *EPA's original ambient water quality criteria for aluminum in freshwater provided a single concentration to all water bodies using a pH range of 6.5 and 9.0 while ignoring hardness and dissolved organic content (DOC). This approach overlooked the fact that aluminum toxicity can be significantly ameliorated by conditions within individual water bodies. EPA promulgated the new aluminum criteria in response to comments from different industries that the previous, one-size-fits-all aluminum criteria for acute and chronic aluminum concentrations were both difficult to achieve and unnecessarily low.*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	The proposed Aluminum Criteria represent dynamic criteria which more accurately reflect aluminum's "real world" toxicity. Recent research indicates that aluminum's observed toxic effects were caused by freely-dissolved aluminum ions, concentrations of which depend upon the chemical characteristics of a given water body. Although the availability of aluminum ions in fresh water vary due to many other factors, aluminum toxicity is generally proportional to a site's DOC, hardness, and pH. EPA's proposed aluminum better criteria reflect this scientific reality and, accordingly, are more scientifically robust. *In summary, we thank and support EPA for promulgating these criteria so that aluminum limits can be appropriately tailored to waters nationwide, rather than imposing an overly conservative, one-size-fits-all criterion. This is a much smarter and appropriate way to provide full environmental protection with substantially reduced regulatory burdens.*		
EPA-HQ-OW-2017-0260-0010 *(Adam D. Link, Director of Government Affairs, California Association of Sanitation Agencies (CASA))*	*CASA and its members have long advocated for responsible rulemaking for protection of public health and the environment alike. The proposed aluminum criteria update represents significant progress since the original 1988 document. Basing evaluations upon an expanded data set and the incorporation of key water quality characteristics enables appropriate, site-substantive assessments of potential aluminum toxicity. In addition, use of the multiple linear regression model (MLR) approach provides a balance between model accessibility and robustness. CASA commends USEPA for its commitment to the protection of aquatic life through use of the best available science.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0021 & EPA-HQ-OW-2017-0260-0022 *(Daryll Joyner, Administrator, Water Quality Standards Program, Florida Department of Environmental Protection (DEP))*	*The Florida Department of Environmental Protection (DEP) has reviewed the Environmental Protection Agency's (EPA) Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. The general methodology for deriving the criteria for aluminum (Al) in freshwater appears to be reasonable and consistent with standard methods used for other toxic pollutants. However, we have a few concerns regarding the development and implementation of the proposed Al criteria. We respectfully submit the following comments and suggestions.*	Thank you for your comment; substantive comments are addressed in detailed responses.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	*CASQA strongly supports updating the recommended aluminum criteria to reflect the latest science concerning the aquatic effects of aluminum. In the sections below we discuss the problems caused by the current (1988) criteria and also our suggestions and comments regarding the proposed new criteria. We are very concerned that many waterways, both natural and impacted by human activity, will be classified as impaired by aluminum when in fact no impairment exists.*	Thank you for your comment; substantive comments are addressed in detailed responses.	No edits.
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	***Comments and suggestions on the Aluminum Notice*** *CASQA strongly supports the use of site-specific water chemistry to develop criteria appropriate for the waterbody being evaluated. The use of the site-specific parameters for pH, dissolved organic carbon (DOC), and hardness will result in water quality criteria that more accurately reflect the risk of aluminum toxicity to aquatic organisms. We have the following comments and suggestions:*	Thank you for your comments; additional substantive comments are addressed in detailed responses. The EPA agrees that the use of site-specific water chemistry data for developing aluminum criteria is desirable, and the 2018 final aluminum criteria was developed on this basis. The Aluminum Criteria Calculator V.2.0 enables site-specific criteria derivation that addresses local water chemistry.	No edits.
EPA-HQ-OW-2017-0260-0028 *(Joshua D. Schimmel, Executive Director, Springfield Water and Sewer Commission (SWSC))*	*As the second largest public water system in Massachusetts, our mission is to provide a continuous supply of potable water to out 250,000 customers. The SWSC currently holds an individual NPDES permit that expires on November 30, 2017. The SWSC supports EPA's efforts to update its recommended aluminum criteria to reflect the latest science, as the current criteria have not been revised since 1988. The new criteria focus on aluminum toxicity and bioavailability of aluminum to invertebrates and vertebrates rather than a set value, which would allow for system-specific responses without compromising protection of our environment.* *The 1988 criteria were based on the impacts of dissolved aluminum concentrations on eight species of invertebrates and seven species of fish, for a total of 15 species. The new criteria are improved as it is based on the effects of Total Recoverable Aluminum in studies of eleven species of invertebrates, eight species of fish, and one frog species. The new criteria also take site-specific ambient water quality into account, including the presence of dissolved organic carbon, hardness, and pH, which influences the bioavailability of aluminum to aquatic species. In our own receiving water, Cooks Brook, background levels of Total Recoverable Aluminum often exceed the current 87 µg/L national water quality standard, but as the brook's pH is near neutral, aluminum is less available to the fish and aquatic life. These new parameters in the criteria would allow higher levels of aluminum*	Thank you for your comment. To clarify, the 1988 criteria were applicable for total recoverable aluminum, not dissolved aluminum. It is accurate that the 2018 final aluminum criteria recommendations, also applicable for total recoverable aluminum, involve the use of site-specific ambient water chemistry data, specifically pH, hardness and DOC, for criteria calculations, to provide appropriately protective aluminum criteria.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	in our dischargers without compromising toxicity limits. *Without the site-specific parameters of the new criteria, the SWSC could be forced into the position of being unable to comply with the Clean Water Act while also complying with the Safe Drinking Water Act Regulations. Like many Public Water Systems, the SWSC uses an aluminum-based product, an inorganic salt (PC 2800), as a coagulant in our drinking water treatment process. With the addition of PC 2800 to the West Parish Filters Rapid Sand filtration plant, our disinfection by-products are below the Stage 2 Disinfection Byproducts Rule (DBPR) Maximum Contaminant Level (MCL). Without the enhanced coagulation step our DBP numbers would most likely climb above the MCL and push us towards a violation of the Stage 2 DBPR regulation limits. The proposed Aluminum Criteria Calculator will help us to determine the allowable aluminum limits using site-specific dissolved organic carbon (DOC), pH, and hardness, enabling systems like ours to continue to use aluminum-based coagulants in our treatment process.* *Overall the draft criteria are well-written and organized and the SWSC believes the proposal should move forward. We offer the following comments for EPA's consideration:*		
EPA-HQ-OW-2017-0260-0028 *(Joshua D. Schimmel, Executive Director, Springfield Water and Sewer Commission (SWSC))*	*With these new proposed criteria, the SWSC believes it will be able to more effectively balance protection of the health and safety of our customers with the protection of aquatic life forms from the effects of aluminum toxicity.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0029 *(Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))*	***Background*** *The USEPA developed draft aquatic life ambient water quality criteria for aluminum in freshwater (EPA-822-P-17-001; July 2017). This draft is an update of the 1988 aluminum criteria and provides EPA's scientific assessment of the ecological effects of aluminum on aquatic life in freshwater. The draft criteria were released for public comment on July 28, 2017 (See, 82 FR 35198) with comments due on or before September 26, 2017.* *The current (1988) freshwater aluminum criteria set acute and chronic impairment thresholds of 750 µg/L and 87 µg/L, respectively, as total recoverable metal over a pH range of 6 - 9. The chronic criterion is flagged with the following warning*	Thank you for your comment; substantive comments are addressed in detailed responses. EPA disagrees with the commenter's assertion that the Water Effect Ratio applied to the superseded 1988 aluminum criteria is more appropriate than the 2018 final aluminum criteria which reflects the current and best available science. The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	concerning the suitability of this criterion: *There are three major reasons why the* <u>*use of Water-Effect Ratios might be appropriate*</u>*. (1) The value of 87 µg/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however,* <u>*the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide*</u>*. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured. (Emphasis added)* *As noted in the footnote with the chronic aluminum criterion, EPA has long known that pH and hardness influence the toxicity of aluminum. These draft criteria have been developed to address these known confounding factors. The revised draft criteria are a function of pH, hardness, and dissolved organic carbon (DOC) and represent a dramatic improvement over the current criteria.* *However, the revised draft criteria still include significant uncertainties that warrant site-specific adjustment.*	Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has recently been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters.	
EPA-HQ-OW-2017-0260-0034 *(James Boswell, Senior Manager, Environmental, Peabody Energy)*	*Overall Peabody agrees with the EPA's proposed approach to use multiple linear regression (MLR) to develop the draft criteria and feels it is a significant improvement over the 1988 criteria and incorporates the latest science. Peabody has some concerns with EPA's approach in the draft criteria. Those concerns are focused on 1) the form of aluminum in the criteria, 2) the range of hardness, 3) the range of pH, and 4) applicability issues with selected species in different regions of the U.S.*	Thank you for your comment. Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		were thus expanded, with details and rationale provided in the criteria document, and in the responses above. The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters.	

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		Species included in a sensitivity distribution for criteria are considered surrogates for other taxonomically-related species, due to genetic conservation of important toxicity response traits in species. For example, fish in the family Salmonidae, such as the Atlantic salmon, include many recreationally and commercially important species, as well as endangered species, which are have broad relevance across the U.S.	
EPA-HQ-OW-2017-0260-0035 *(Richard A. Hyde, P.E., Executive Director, Texas Commission on Environmental Quality (TCEQ))*	***Comments on Proposed Standards*** *I. General Comments and Overview.* ***A. The TCEQ supports the development of criteria using site-specific water chemistry.*** *It is appropriate to consider the impact of water chemistry on the toxicity of aluminum in freshwater to aquatic species. The TCEQ has adopted site-specific toxic criteria for aluminum in fresh water using Water-Effect Ratio (WER) procedures agreed upon by the EPA and the TCEQ. These procedures have allowed the TCEQ to recognize and incorporate the effects of local chemistry on the bioavailability and toxicity of metals, including aluminum. Consideration of local water chemistry is particularly important to develop appropriate criteria for aluminum, due to its interactions with complexing ions and organic matter in freshwater.*	Thank you for your comment. EPA asserts that the 2018 final aluminum criteria, which reflects the current and best available science and allows incorporation of local water chemistry considerations, is more scientifically defensible than the Water Effect Ratio applied to the superseded 1988 aluminum criteria.	No edits.
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	*We are pleased to see that EPA is updating the national freshwater aquatic life ambient water quality criteria to take into account water quality parameters that affect Aluminum toxicity and bioavailability. The current Aluminum criteria, adopted by EPA in 1988, does not appear to be appropriate for receiving waters in the New England region. The Massachusetts Department of Environmental Protection (MassDEP) has been in the process of reviewing their surface water quality standard for Aluminum and were expected to move forward with proposing changes to their regulations this fall, as they felt the current criteria to be overly conservative for many of Massachusetts' waters. These proposed criteria could impact the state's adoption of new surface water quality standards.*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*Our states have identified that the Draft Aquatic Life Ambient Water Quality Criteria for Aluminum 2017 is, overall, an excellent and valuable document. We agree that the scientific findings are defensible and accurate. It is understood that the new limitations, while higher than those from the 1988 criteria, will not increase the risk to aquatic ecosystems due to the bioavailability of aluminum when properly derived and applied, and in fact, these new draft criteria are more reflective of local conditions. NEIWPCC encourages EPA to move forward and finalize these Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*The State of New Mexico Environment Department (NMED) has reviewed the Environmental Protection Agency's (EPA's) draft Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. The NMED appreciates the work and thoroughness put forth to revise the 1988 aluminum guidance, which was instituted almost 30 years ago. Overall, the primary literature supporting the new guidance appears to be well vetted and contributes to a more comprehensive understanding of aluminum bioavailability and toxicity for aquatic organisms in ambient freshwater systems.* *The toxicological nature of aluminum is complex and the scientific research exploring the various modes of exposure, and conditions in which aluminum can pose harmful physiological impacts is expanding, but in many ways, it is still unbound in the scope to which it needs to be explored. Due to the limited period of time afforded to the public and government entities that will be responsible for implementing such guidance, the State of New Mexico's comments submitted here are limited to a broad overview of the study, as presented, and some of the foreseen potential implications of implementing these multi-parameter derived criteria.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0046 *(Jennifer Wigal, Program Manager, Water Quality Standards & Assessments, Oregon Department of Environmental Quality)*	*DEQ supports EPA's trend in developing recommended national water quality criteria that account for the effects of site-specific water chemistry on toxicity, as this approach improves the accuracy and protectiveness of criteria.*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0047 *(Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))*	*The North American Metals Council (NAMC) In addition to the points set forth below, NAMC supports and incorporates by reference here the positions and views expressed in comments submitted by the Aluminum Association. We are encouraged and extremely supportive of the EPA effort to endorse a bioavailability-based model in deriving the revised aluminum criteria and to consider site-specific water quality conditions in the development of those criteria. Our comments below are aimed at insuring implementation can be done in a manner that is both scientifically defensible and acceptable to the States.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0047 *(Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))*	***MLR Modeling Approach*** *NAMC supports the EPA proposal to update the ambient water quality criteria for aluminum as the current approach uses an outdated approach to deriving criteria and does not reflect today's scientific advancements. The proposed approach using a MLR model allows for the incorporation of bioavailability of aluminum into the criteria dataset, thus providing protection for even the most sensitive waters of the U.S. without over protecting many non-sensitive waters. NAMC notes some key areas for further EPA consideration below.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*On behalf of the Aluminum Ecotoxicity Research Group [Eirik Nordheim, European Aluminium Association, nordheim@european-aluminium.eu; William Adams, PhD, Red Cap Consulting, Adamsw10546@gmail.com; Robert Gensemer, PhD, GEI Consultants, Inc., bgensemer@geiconsultants.com; Robert Santore, PhD, Windward Environmental, LLC., RobertS@windwardenv.com; David DeForest, Windward Environmental, LLC., DavidD@windwardenv.com; Patricio Rodriguez, PhD, CIMM, phr.consulting@outlook.com; Bill Stubblefield, PhD, Oregon State University, bill.stubblefield@oregonstate.edu; Allison Cardwell, Oregon State University, allison.cardwell@oregonstate.edu], we appreciate the opportunity to provide comments on the USEPA's 2017 Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. Our group has been developing empirical toxicity test data and bioavailability models for aluminum for close to a decade. EPA's recent revision of the aluminum criteria document is extremely timely and reflects the current state-of-the-science for the evaluation of the potential effects of metals in the environment. We are encouraged and extremely supportive of the EPA's efforts to endorse a bioavailability-based model in deriving the revised aluminum*	Thank you for your comment; substantive comments are addressed in detailed responses.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	criteria and to consider site-specific water quality conditions in the development of that criteria. *As you will see, our comments consist of a series of general overall comments that apply to the document or to the scientific approach employed, followed by a series of specific comments that are defined by page number and section. These are comments which our group believes to be very important considerations in assessing the appropriateness and thoroughness of the draft water quality criteria as it has been written.*		
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xii* *Sentence: EPA reviewed these models, published by DeForest et al (2017), and verified the results. Thus, the aluminum criteria were derived using MLR models that incorporate pH, hardness and DOC as input parameters.* *Comment: We appreciate that the Agency reviewed and supports the use of the MLR approach. This approach is state of the science and provides the right level of protection for each water body based on the site water chemistry. The previous use of one value for all waters of the US is clearly scientifically outdated.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*First, the District would like to express its strong support for the EPA's decision to review and update the water quality criteria for aluminum. In addition, we support the EPA's recommendation to include appropriate adjustments for site-specific water chemistry conditions such as pH, hardness, and dissolved organic carbon (DOC) concentrations that significantly affect the potential toxicity of aluminum.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0051 *(Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))*	*MassDEP is pleased that the U.S Environmental Protection Agency (EPA) is in the process of updating the aluminum freshwater aquatic life ambient water quality criteria recommendation in accordance with §304(a) of the Clean Water Act (CWA). MassDEP respectfully submits the following comments on EPA's document entitled Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater, published on July 28, 2017 [Docket ID No. EPA-HQ-OW-2017-0260].* *EPA's Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater, published on July 28, 2017, provides a thoughtful review of the water quality parameters (pH, hardness and dissolved organic carbon (DOC)) that affect aluminum bioavailability and toxicity. EPA's current recommended water quality criteria (750 micrograms per liter (µg/L) acute; 87 µg/L*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	chronic) [EPA 440/5-86-008, 1988], which has been adopted by MassDEP, are absolute numbers that are not adjusted to site-specific water quality conditions. DOC has been documented to ameliorate the bioavailability of aluminum and therefore aluminum toxicity; relatively high concentrations of DOC (up to 12 milligrams per liter (mg/L)) have been measured in Massachusetts' surface waters, thus reducing the bioavailability of aluminum in many of our surface waters. Because the current EPA criteria for aluminum does not incorporate these unique surface water conditions, MassDEP asserts that EPA's 1988 aluminum criteria are overly conservative for many of Massachusetts' waters. MassDEP believes that these new draft criteria are more reflective of local conditions and encourages EPA to move forward with finalizing these criteria for aluminum in freshwater. MassDEP is offering the following specific comments on the draft guidance for EPA's consideration.		
EPA-HQ-OW-2017-0260-0051 *(Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))*	*1. EPA's Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater includes a user-friendly Aluminum Criteria Calculator V.1.0 (Aluminum Criteria Calculator V.1.0.xlsx) that allows users to enter site-specific values for pH, total hardness and DOC to calculate the appropriate recommended freshwater acute and chronic criteria. MassDEP believes this will be a useful tool for regulators and permit holders. This calculator incorporates an approach to derive aluminum criteria in freshwater systems using multiple linear regression (MLR) models with pH, hardness and DOC as input parameters.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0056 *(Chris Burbage, Ph.D., Environmental Scientist, Hampton Roads Sanitation District (HRSD), Virginia Beach, VA)*	*With respect to the EPA request for scientific and technical views, HRSD offers the following comments for review.* ***<u>Comment 1: Revision of 2008 freshwater aluminum aquatic life ambient water quality criteria</u>.*** *HRSD approves of the revised 2017 EPA effort updating the freshwater aluminum AWQC.* *The 2017 criteria is the product of additional laboratory toxicity tests of aluminum on aquatic life published from 1988 to 2015. Additionally, supplemental toxicity data from 2016 to 2017 was also used. The original 1988 criteria document included toxicity data from only 15 total species (representing 14 genera), however the new 2017 criteria includes a total of 20 species, including an amphibian (representing 18 genera). The addition of new test*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	species allows for minimum data requirements (MDRs) to be met for the calculation of both freshwater Final Acute and Chronic Values (FAV and FCV). *The fulfillment of MDRs as described in the 1985 EPA guidance document (Stephen et al. 1985) provides for scientifically defensible water quality criteria for aluminum. These newly derived freshwater FAV and FCV values provide freshwater aquatic organisms sufficient protection without placing undue burden on the public.*		
EPA-HQ-OW-2017-0260-0056 *(Chris Burbage, Ph.D., Environmental Scientist, Hampton Roads Sanitation District (HRSD), Virginia Beach, VA)*	***Comment 2: Inclusion of ambient water quality characteristics (pH, DOC, hardness) in normalizing toxicity data***. *HRSD supports the use of Multiple Linear Regression (MLR) models for the determination of aluminum water quality criteria.* *The 2017 criteria establishes an aluminum freshwater criteria taking into account the effects of pH, total hardness, and dissolved organic carbon on the biological uptake potential of aluminum via gill tissue. MLR models were developed by DeForest et al. (2017) to characterize the bioavailability of aluminum for freshwater aquatic organisms based on the above chemical properties. DeForest et al. (2017) established the relationship between pH, DOC, hardness and aluminum toxicity through a series of vertebrate (Pimephales promelas) and invertebrate (Ceriodaphnia dubia) chronic toxicity tests. These tests were used to evaluate the ability of MLR models to accurately predict aluminum toxicity given multiple combinations of model parameters.* *The use of these MLR models allows for an accurate assessment of aluminum toxicity for a given freshwater location that may have varied chemical (pH, hardness, and DOC) conditions. These models allow for small scale variations of water quality parameters while still protecting freshwater organisms.*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0056 *(Chris Burbage, Ph.D., Environmental Scientist, Hampton Roads Sanitation District (HRSD), Virginia Beach, VA)*	***Comment 3: Inclusion of calculator for users*.** *HRSD supports the inclusion of the Aluminum Criteria Calculator for the assessment of site specific freshwater acute and chronic water quality criteria.* *HRSD is supportive of the development of the criteria "calculator", however there is concern regarding the appropriate use of data generated by this tool. The "calculator" and its use of site specific water quality information (pH, hardness, and DOC) in predicting protective aluminum limits is an improvement over the original 1988 criteria which had fixed values. The calculator allows for a set range of values to be used in support of this model. If parameter data is used that falls outside of these acceptability ranges the calculator issues a warning stating caution in using produced results for site assessment. HRSD is concerned that the calculator will be preferentially used for the assessment of aluminum criteria, and limit the availability of other assessment tools. For instance, EPA's continued assessment of the use of the biotic ligand model (BLM) in setting specific aluminum criteria should not be suspended. Likewise the ability to calculate site-specific aluminum criteria such as Water Effects Ratio (WER) studies should not be impacted. The BLM and WER are valuable tools that should continue to be available for aluminum criteria assessment in addition to the newly developed "calculator".*	Thank you for your comment. Please reference Section 5.3.5 for the rationale as to why the EPA chose to pursue the MLR models published by DeForest et al. (2018a, b) over the BLM approach (Santore et al. 2018). EPA asserts that the 2018 final aluminum criteria, which reflects the current and best available science and allows incorporation of local water chemistry considerations, is more scientifically defensible than the Water Effect Ratio applied to the superseded 1988 aluminum criteria.	No edits.
EPA-HQ-OW-2017-0260-0056 *(Chris Burbage, Ph.D., Environmental Scientist, Hampton Roads Sanitation District (HRSD), Virginia Beach, VA)*	***Comment 4: Continue to provide information regarding reasons why specific studies were not used in water quality criteria development*.** *HRSD supports the inclusion of information that was rejected for inclusion in the criteria development process. The documentation of information that was not utilized in the development process with appropriate explanations as to the reason for its omission provides a degree of transparency for the public. This is beneficial for the development of the aluminum criteria but also subsequent criteria that have yet to be developed. This omitted data with appropriate explanations demonstrates to the public what types of data quality are required for inclusion in criteria development. If the public is supportive of the rationale for inclusion or omission of specific data then their support of a given criteria will be that much greater.*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*The American Petroleum Institute (API) represents over 625 companies involved in all aspects of the oil and natural gas industry (Exploration, Production, Refining, Marketing and Transportation). We have a substantial interest in federal agency activity impacting our member companies' operations under the Clean Water Act (CWA) water quality standards program. API member companies have facilities in all states and territories of the United States (U.S.) that generate wastewater, require NPDES permits to discharge, and may be subject to permit limits based on aluminum criteria.* *API appreciates the opportunity to comment on EPA's Notice of Availability, Request for Scientific Views: Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater (82 Fed. Reg. 35198, July 28, 2017, hereafter "Notice") and associated draft document, Draft Aquatic Life Ambient Water Quality Criteria for Aluminum 2017 (EPA 822-P-17-001). The criteria derivation incorporates recent research into the physical and environmental chemistry of aluminum that drives bioavailability and thus ecological effects to aquatic life. It is clear EPA and its collaborators have carefully designed and conducted high-quality testing programs to populate the toxicity models.* *While the proposed multiple linear regression (MLR)-based criteria are an improvement over the 1988 criteria, there are still technical and implementation limitations which should be addressed before the criteria are finalized. Given the age of the existing criteria and unlikelihood of timely updates there is a concern that if these issues are not addressed prior to finalizing the criteria, they will be problematic for decades; API suggests they should be resolved before the final guidance is issued.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0058 *(National Council for Air and Stream Improvement, Inc. (NCASI))*	*The National Council for Air and Stream Improvement, Inc. (NCASI) respectfully submits the following comments on EPA's Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater and the associated technical support document (EPA 2017). NCASI is an independent, non-profit research institute that focuses on environmental topics of interest to the forest products industry. Members of NCASI represent approximately 90% of the pulp and paper production in the United States. In its capacity as a research organization, NCASI has a long history of working to contribute to the science needed to address numerous environmental topics related to the forest*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	products industry including effluent regulation, water quality management, and relationships between human and natural stressors on aquatic ecosystems. Additionally, in its capacity as a research organization, NCASI has a long history of collaboration with EPA on the use of sound science needed for the development and implementation of responsible environmental management practices. Evidence of this ongoing collaboration is seen in the selection of NCASI scientists as participants in numerous EPA Science Advisory Board and other panels relating to surface water quality. NCASI's comments on the draft criteria document are presented below. *The proposed criteria and methods, including use of a multiple linear regression (MLR) procedure, represent an improvement over the existing criteria because they are based on the use of additional test species and science-based knowledge to adjust criteria values for water quality. Nonetheless, we identify and describe several concerns for EPA's consideration prior to adopting revised criteria.*		
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	***COMMENTS OF THE UTILITY WATER ACT GROUP ON:*** *UWAG's purpose is to participate on behalf of its members in EPA's rulemakings under the CWA and in litigation arising from those rulemakings.] appreciates this opportunity to comment on EPA's "Draft Aquatic Life Ambient Water Quality Criteria for Aluminum," (EPA-822-P-17-001) (defined here as the "Draft Criteria"), which was released for public review on July 28, 2017, 82 Fed. Reg. 35,198. The Draft Criteria uses multiple linear regression (MLR) models to derive site-specific aluminum criteria based on the pH, hardness, and dissolved organic carbon (DOC) of the waterbody.* *Aluminum is an ubiquitous crustal element of the earth's lithosphere. As such, the element is present in near-surface strata, including coal deposits. Many UWAG members own and operate fossil fuel-fired electric generating facilities, including coal-fired. The extraction and combustion of coal results in waste and wastewater streams that may contain aluminum. Therefore, the development of water quality criteria for aluminum is of interest to UWAG.* *Aquatic life criteria, including for aluminum, should be adequately protective; they should not, however, be overly conservative such*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses. Since the 2017 draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria were expanded, with details and rationale provided in the criteria document and summarized below. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5. For hardness values, the criteria calculator allows entry of values between 0.01 and 430 mg/L total hardness; criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). For DOC, the criteria calculator will not extrapolate below the lowest empirical DOC of 0.08 mg/L and upper limit of the empirical MLR models will be bounded at a maximum 12.0 mg/L DOC in the criteria calculator; criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	that unnecessary regulatory burdens are imposed on economic activities important to the states and the nation. Overall, UWAG believes the scientific basis of the Draft Criteria is relatively sound, at least for the ranges of the parameters in the underlying data used in developing the MLR models – pH of 6.0 to 8.1; hardness up to 150 mg/L as CaCO3; and DOC of up to 5.0 mg/L. Outside of those ranges, however, the scientific validity is questionable. *These comments focus on the technical aspects of the Agency's derivation of the Draft Criteria to enhance the robustness of the final updated criteria.*		
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	*6. **EPA's use of the wood frog data for the freshwater chronic criterion was appropriate.*** *UWAG agrees with EPA's use of an amphibian (wood frog) chronic test result to satisfy the 1985 Guidelines eight-family minimum data requirement (MDR). If this data point were not used, the chronic criterion would need to be calculated using an acute-to-chronic ratio (ACR). Chronic criteria developed using ACRs, in some cases, have high uncertainty and thus could be under-protective (Raimondo et al. 2007). Also, the dose-response pattern of acute exposures to a particular organism may be different than the dose-response pattern for chronic exposures.* *[Cited References]*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0063 *(Kevin Oakes, Director of Wastewater, Borough of West Chester, Chester County, Pennsylvania)*	***Comments on Proposed Water Quality Criteria*** *A. The Borough of West Chester supports the development of water quality criteria based on site-specific water chemistry and logical and scientific approaches.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0066 *(David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)*	*United States Steel Corporation (U.S. Steel) is submitting the following comments to the Environmental Protection Agency (EPA) in support of the Federal Water Quality Coalition (FWQC) comments submitted by Barnes & Thornburg LLP on the Notice of Availability of Request for Scientific Views: Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. U.S. Steel is a member of the American Iron and Steel Institute (AISI), who is represented in the FWQC as indicated in the Barnes & Thornburg LLP comment letter.* *The Draft Criteria will be considered by States in adopting water*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	quality standards for aluminum, and in issuing effluent limits for aluminum in discharge permits. U.S. Steel, like the FWQC, generally supports the Multiple Linear Regression (MLR) approach which incorporates receiving waterbody quality for deriving a site-specific aluminum quality criteria. U.S. Steel also has the same concerns as the FWQC that we believe must be addressed before the recommended criteria guidance document is finalized. The following is a summary of these issues:		
EPA-HQ-OW-2017-0260-0068 (Rachel Gleason, Executive Director, Pennsylvania Coal Alliance (PCA))	*By way of background, Pennsylvania's aluminum criteria was approved by US EPA Region 3 in 2001 when the Commonwealth adopted US EPA's acute criterion, but rejected US EPA's chronic criterion due to problems with the science on which it was developed. While we appreciate the US EPA revising the 1988 Criteria and the flexibility that the draft criteria could provide to operators when treating effluent limitations to meet the aluminum limits, there are still some major concerns and clarifications that need addressed by US EPA prior to final publication.*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses.	No edits.
EPA-HQ-OW-2017-0260-0071 (Fredric P. Andes, Coordinator, Federal Water Quality Coalition (FWQC))	*The Draft Criteria for aluminum are based on a Multiple Linear Regression (MLR) approach. Using that approach, EPA's document provides for derivation of site-specific water quality criteria, based on the levels of pH, hardness, and dissolved organic carbon (DOC) in that waterbody. The FWQC believes that this approach represents a substantial scientific improvement over the methods that EPA has used in the past to develop recommended aluminum criteria. However, our review of the Draft Criteria has yielded a number of significant technical and implementation concerns. We believe that it is critical for EPA to address these issues before it finalizes the recommended criteria. Those issues are set forth below.*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses.	No edits.
EPA-HQ-OW-2017-0260-0073 (Curt Wells, Director of Regulatory Affairs, The Aluminum Association)	***Multi-Linear Regression (MLR) modeling approach*** *The Association supports the EPA's work to update the ambient water quality criteria for aluminum. The current nationally recommended criteria date to 1988, and significant additional data is now available to support their revision. EPA proposes using the multiple input (pH, hardness, and DOC) MLR methodology as outlined in the draft criteria document. In particular, the Association asks that EPA proceed with this work consistent with its existing 1985 Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses "1985 Guidelines"), and that it continue to collaborate with aluminum toxicology experts such as those involved with the Aluminium REACH Consortium to reach a final*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 7: Regarding compliments to Aluminum AWQC development	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	updated aluminum ambient water quality criteria that accurately reflects the best available science.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*GEI Consultants, Inc. (GEI), on behalf of the Aluminum Association, has reviewed the United States Environmental Protection Agency's (EPA) 2017 Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. Our review focused primarily on assessing which toxicity studies were deemed acceptable by EPA for inclusion in the criteria development, the rationale for their inclusion, and whether the results from these studies were used appropriately and in accordance with the 1985 EPA Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses. Additionally, we have reviewed whether the draft criteria document addresses aluminum chemistry and bioavailability under field conditions as opposed to the simpler laboratory water quality conditions used in the toxicity tests from which the draft criteria were derived.* *We appreciate the efforts EPA has taken to evaluate the new toxicity data and bioavailability models for aluminum that have recently been published. We conclude that EPA's draft aluminum criteria represent a significant improvement in the scientific reliability of these criteria compared to EPA's original aquatic life criteria (EPA 1988). The inclusion of water quality-based criteria calculations for pH, hardness, and dissolved organic carbon (DOC) represent significant improvements, and will provide for much more accurate levels of aquatic life protection than the older fixed criteria concentrations. Based on our review of the draft EPA criteria, we provide the following comments regarding several issues which we believe warrant further explanation or clarification from EPA.*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses.	No edits.
EPA-HQ-OW-2017-0260-0075 *(Steven A. Buffone, CHHM, QEP, GIT, Supervisor, Compliance and Regulatory Affairs, CONSOL Energy Inc.)*	*We commend the EPA for reviewing the 1988 AWQC Criterion and proposing a draft revision that could offer more flexibility to operators when treating effluent to meet the aluminum limits, however there are still some concerns and clarifications that should be addressed by EPA prior to final publication.*	Thank you for your comment; substantive comments are addressed subsequently in detailed responses.	No edits.

TOPIC 8: Comments regarding the document in general

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0064 *(Scott G. Mandirola, Director, West Virginia Department of Environmental Protection (WVDEP))*	*While reviewing the studies EPA used to calculate the Draft Aluminum Criteria, WVDEP was concerned that some of the data EPA used has been available for review by the public for only a very short time. Regardless of this difficulty presented in reviewing these very recent studies, WVDEP noted that EPA made decisions that differed from WVDEP's analysis for inclusion and exclusion of some studies. These data decisions affected the outcome of the Genus Mean Acute Values (GMAVs) and thus the Criterion Maximum Concentration (CMC). For instance, this caused Ceriodaphnia, the most sensitive species in West Virginia's analysis, not to be among the top 4 most sensitive species in the EPA analysis. In addition, while the West Virginia database was normalized for hardness, the EPA normalized using the multiple linear regression for hardness, pH, and DOC. EPA's multiple linear regression approach makes assumptions. For instance, for Daphnia, using regression assumes all invertebrates react to aluminum as Daphnia do.* *To calculate the criterion continuous concentration (CCC), instead of using an acute to chronic ratio, as recommended by the 1985 Guidelines, EPA went with a chronic database to calculate a final chronic value (FCV). The 1985 Guidelines state "to derive a criterion for freshwater aquatic organisms and their uses, the following should be available ... acute-chronic ratios [sic] with species of aquatic animals in at least three different families" (Guidelines 1985).*	The 1985 Guidelines recommendations were followed regarding acceptability of specific tests. The CCC was calculated using the eight family minimum data requirement approach as recommended by the Guidelines. This approach has less uncertainty than the acute-to-chronic ratio (ACR) approach. As noted in the document, data were normalized for pH, total hardness and DOC to represent the most current scientific information (e.g., DeForest et al 2018), reflecting known factors driving bioavailability and toxicity of aluminum.	No edits.
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*4. Recent studies suggest that initial toxicity trial conditions, rather than natural water conditions, may dictate observed negative salmonid physiologic responses (Poleo & Hyttemd, 2003; Winter et al.,2005; Cardwell et al., 2017). This is a crucial unknown as reactive aluminum intermediates formed in mixing waters of differing pH could lead one to erroneously conclude that steady-state aluminum at alkaline pH is toxic to aquatic life. Ageing of aluminum solutions with toxicity exposure waters is acknowledged in the guidance document, but the State of New Mexico would like the guidance to clarify whether studies used in the development of the draft guidance accounted for aluminum ageing.*	Text was added to document clarifying that not all studies accounted for aluminum aging prior to test initiation. Newer studies are elucidating the aging of solutions, which will provide a better understanding of the aquatic toxicity/bioavailability of aluminum.	Section 2.3

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	***Additional Comments*** *WDEQ/WQD commends EPA for the extensive collection and presentation of toxicity data in the appendices of the draft document. Though these tables are very useful, WDEQ/WQD has noticed several discrepancies among the appendices. WDEQ/WQD did not see any test duration or assessment endpoint information listed for the studies in Appendix A or B. Further, the studies in Appendix E, F and I do not include any information on DOC concentrations. If available, WDEQ/WQD requests that EPA include this information so each study can be fully evaluated.*	Thank you for your comments. As stated in Section 3.1 of the document: "Most fish and invertebrate data are from acute toxicity tests that were 96 hours in duration, except the tests for cladocerans, midges, mysids and certain embryos and larvae of specific estuarine/marine groups, which were 48 hours in duration." Thus, all studies provided in Appendix A (FW acute) and Appendix B (SW acute) adhered to the recommended test duration. Text has been added to clarify that the assessment endpoint (either EC_{50} or LC_{50} depending on the species) also followed Guidelines recommendations. The EPA chose not to add the DOC column to Appendices E, F and I. In Appendix E (Acceptable Toxicity Data of Aluminum to Freshwater Aquatic Plants) and Appendix F (Acceptable Toxicity Data of Aluminum to Estuarine/Marine Aquatic Plants), studies often did not report DOC and there were not enough data to develop criteria. Appendix I (Other Data on Effects of Aluminum to Estuarine/Marine Aquatic Organisms) contains data that are not used in the criteria derivation because they were not of sufficient quality.	Section 3.1
EPA-HQ-OW-2017-0260-0025 *(Peter T. Goodmann, Director, Kentucky Division of Water)*	*The Kentucky Division of Water appreciates the opportunity to comment on the Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater (EPA-HQ-OW-2017-0260).* *A review of the material raises several concerns regarding the draft criteria. The document narrative indicates that the curation of the recommended acute limit is one hour, however, the table in the Executive Summary and Table 9 both indicate a duration of one day. The division urges the EPA to resolve this discrepancy in amount of time recommended for the acute limit.*	Thank you for your comment, the typo was fixed in both tables and edited to be a "1-hour average."	Executive Summary Table 9
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	***7. Corrections or clarifications*** *Tables in the Fact Sheet and the Draft Criteria Document show the freshwater acute criteria as "1 day, total aluminum" for both the current and proposed criteria. However, on page xi, the document states, "The criteria durations are one-hour average for acute and 4-day average for chronic, respectively …" In addition, the 1988 Criteria Document states that the acute criterion is a one-hour average concentration.*	Thank you for your comment, the typo was fixed in both tables and edited to be a "1-hour average."	Executive Summary Table 9 Fact Sheet

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	***The 2017 Criteria Document*** *Page xii of the 2017 criteria document states that the "1988 aluminum freshwater acute criterion was based on* ***dissolved*** *aluminum concentrations…" and that "This 2017 draft criteria update is based on* ***total*** *aluminum concentrations…" However, text on pages 20 to 21 of the 2017 document contradicts the above, stating that the "1988 AWQC criteria [The phrase, "AWQC criteria," literally says "ambient water quality criteria criteria." This error occurs at least five times in the draft document. This is a hazard with overuse of acronyms; they tend to lose meaning to readers (and authors)] for aluminum were based on* ***acid-soluble concentrations****, and were subsequently* ***expressed in terms of total recoverable aluminum****. The current EPA approved CWA Test Methods for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measure* ***total recoverable aluminum****."* *Pages 3 and 4 of the 2017 document define what the various terms mean, stating, "the terms filtered, dissolved, unfiltered, and total and their relationships are defined below. "Dissolved" refers to constituents that exist in chemical solution in a water sample. The designation "filtered" pertains to constituents in a water sample passed through a filter membrane of specified pore diameter, most commonly 0.45 micrometer or less for inorganic analytes. Therefore, for interpretation, the filtered samples will be assumed to be dissolved aluminum. "Total" pertains to the constituents in an unfiltered, representative water-suspended-sediment sample. This term is used only when the analytical procedure includes an* ***acid digestion procedure*** *that ensures measurement of at least 95 percent of the constituent present in both the dissolved and suspended phases of the sample. Therefore, for interpretation, the unfiltered samples will be assumed to be total aluminum."*	Thank you for your comment. Additional information has been added to clarify terminology. In addition, text was edited to be consistent with identified terms.	Section 2.1 Section 2.6.2
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	***NDEP BWQP – Sequential Technical Comments on Draft Aquatic Life Ambient Water Quality Criteria for Aluminum (EPA 2017)*** *1. <u>Page xii of the Executive Summary</u> states that, "The 1988 aluminum freshwater acute criterion was based on dissolved aluminum concentrations and data from 8 species… This 2017 draft criteria update is based on total aluminum concentrations…"* *The reference to "dissolved aluminum" appears to be an* ***incorrect statement****. Page 14 on the 1988 criterion document states "…it is*	Thank you for your comment. Additional information has been added to clarify terminology used. In addition, text was edited to be consistent with identified terms.	Section 2.1 Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	recommended that aquatic life criteria for aluminum not be expressed as dissolved aluminum." The 1988 document also further states that "…not enough data are available concerning the toxicity of dissolved aluminum to allow derivation of a criterion based on dissolved aluminum." *Instead, the 1988 document appears to define three states of aluminum in water samples:* • *field-filtered (i.e., dissolved);* • *acidified before filtering (i.e., acid soluble, which some also take as "total");* • *digested in the lab (i.e., total recoverable)*		
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*McCauley et al. 1986 – C. dubia (page C-2)* *Although not used in the calculation of the SMCV , the MATC value reported in the table is <1,100 µg/L, while the MATC value reported in McCauley et al. 1986 is estimated at 1,600 µg/L. Clarification on the difference is recommended.*	An EC_{20} could only be calculated for the Lake Superior water test. The UW lab-water test missed the endpoint (no treatment with insignificant effects). Thus, an EC_{20} is not available for this test (neither TRAP model EC_{20} is recommended for this test).	No edits.
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	***Line Item Comments*** *Page ix (Forward)* <u>*Sentence*</u>*: Alternatively, states and authorized tribes may use derive numeric criteria based on other scientifically defensible methods but the criteria must be protective of designated uses.* <u>*Comment*</u>*: Grammatical error "may use derived". Edit as appropriate.*	Thank you for highlighting this grammatical error, the error was corrected.	Foreword
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*Page ix (Forward)* <u>*Sentence*</u>*: Agency decisions in any particular situation will be made by applying the Clean Water Act and EPA regulations on the basis of specific facts presented and scientific information then available.* <u>*Comment*</u>*: Grammatical error "then available". Edit to "when available".*	Thank you for highlighting this grammatical error, the error was corrected.	Foreword

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EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*Page xiv* *Sentence: The 1985Guidelines…* *Comment: Grammatical error. Please add a space between 1985 and Guidelines.*	Thank you for highlighting this grammatical error, the error was corrected.	Executive Summary
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*Page 2 (Problem Formulation)* *Sentence: aluminiosilicate* *Comment: Please check spelling. Should this be aluminosilicate, not aluminiosilicate?*	Thank you for highlighting this spelling error, the error was corrected.	Section 2.1
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*Page 11* *Sentence: ….at pH of 7.61.and 8.05 and…* *Comment: Grammatical error. Remove period after 7.61, add space.*	Thank you for highlighting this grammatical error, the error was corrected.	Section 2.3
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*Page 23* *Sentence: an LC50* *Comment: Grammatical error. Should be a LC50, not an LC50.*	Thank you for highlighting this grammatical error, the error was corrected.	Section 2.6.2
EPA-HQ-OW-2017-0260-0048 (William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)	*Page 27* *Sentence: Recent publications by Cardwell et al. (2017) and Gensemer et al. (2017) summarized short-term aluminum chronic toxicity data…* *Comment: The citation of Cardwell et al. (2017) in this sentence is incorrect in this sentence and should be removed. Gensemer et al. 2017 summarized these data.*	Thank you for your suggestion, the citation was corrected.	Section 2.7.1

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EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 85, 116, 117* *<u>Sentence</u>: References: Call, OSU, Sauer* *<u>Comment</u>: Spelling errors in references, change Univeristy to University.*	Thank you for highlighting these spelling errors, the errors were corrected.	Section 7
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Appendix L (Page L-2)* *<u>Sentence</u>: Aluminum ACRs could be calculated four freshwater species, a mussel, a cladoceran, an amphipod and a fish. No estuarine/marine ACRs could be calculated.* *<u>Comment</u>: Grammatical error. Suggest revised sentence: Aluminum ACRs could be calculated <u>for</u> four.* *[Cited References]*	The ACR appendix was removed from the final document.	No edits
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	*3. It is well understood that the toxicity of aluminum is influenced by the changes in the pH of surface water. To facilitate states' understanding regarding pH toxicity at various concentrations and to fully protect aquatic organisms from the effects of pH found in natural surface waters, ADEC requests EPA expand on the tables found in Appendix K that present criteria for various water chemistry conditions. The current tables do not sufficiently support the incremental measurements of pH concentrations (e.g., 6.0, 6.1, 6.2) and the level of variation that ADEC expects to see in Alaskan surface waters. Small differences in pH result in large differences in the resulting criteria.*	The Aluminum Criteria Calculator allows users to enter up to 500 individual sets of water chemistry conditions at once to ease facilitation of these incremental pH concentrations. Please use this macro-enabled Excel file to calculate criteria magnitudes that are not presented in Appendix K.	Aluminum Criteria Calculator "Over 20 Scenarios" tab
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	***Other Issues of Concern*** *1. ADEC questions why EPA chooses to incorporate estuarine/marine criteria discussions sections throughout the document when there is not enough data to develop WQC for estuaries and marine environments. For clarity, EPA should publish a separate criteria document when there is enough data to support criteria development or combine the estuarine/marine criteria text and data into an appendix.*	Criteria document updates typically present all available data and information (both freshwater and estuarine/marine) for specific contaminants as recommended by the 1985 Guidelines. Even though estuarine/marine criteria cannot be recommended with this update, the available information can be used by different entities (states, tribes, etc.) in other ways.	No edits.

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*EPA Response to External Peer Review Comments on the Draft Aquatic Life Ambient Water Quality Criteria for Aluminum - 2017 (July 2017)* *Peer-review comments on an earlier draft of the 2017 aluminum criteria document suggest the reviewers were specialists in aquatic toxicology rather than aqueous geochemistry. If so, the critical issue of aluminum solubility in natural waters (i.e., "dissolved" versus "total") may not have been sufficiently addressed during the peer-review process. Indeed, a word search of the July 2017 "EPA Response to External Peer Review Comments," finds no match for "field-filtered" or "filtered." Reviewer 4 did, however, comment that a "Paragraph starting at the bottom of page 2 might be an appropriate place to mention aluminum solubility and Ksp (unless a separate section on chemistry is adopted per my suggestion above). This is an important concept in nature and a really important concept in the toxicity experiments" and "Page 9 near the top of the page says that at neutral pH aluminum is nearly insoluble – this should be quantified. The Ksp of aluminum hydroxide allows clear estimation of the solubility limits of aluminum."* *EPA's response to both of the above comments was that because "several sources had conflicting Ksp values for Al(OH)3 so we did not add this information." The NDEP notes that there is disagreement of Ksp values for most species, due to the difficulty of obtaining these values experimentally; however, that is not a valid reason for ignoring the concept of solubility products entirely. [Note: the Ksp value is the "solubility product," which is the equilibrium constant for a solid dissolving in aqueous solution, and is typically determined experimentally].*	Text was added to the document clarifying the solubility range for aluminum hydroxide, and solubility values for aluminum chloride, aluminum nitrate and aluminum sulfate.	Section 2.2

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*2. Pages 3-4. The 2017 draft document states that, "The terms filtered, dissolved, unfiltered, and total and their relationships are defined below. "Dissolved" refers to constituents that exist in chemical solution in a water sample. The designation "filtered" pertains to constituents in a water sample passed through a filter membrane of specified pore diameter, most commonly 0.45 micrometer or less for inorganic analytes. Therefore, for interpretation, the filtered samples will be assumed to be dissolved aluminum. "Total" pertains to the constituents in an unfiltered, representative water-suspended-sediment sample. This term is used only when the analytical procedure includes an acid digestion procedure that ensures measurement of at least 95 percent of the constituent present in both the dissolved and suspended phases of the sample. Therefore, for interpretation, the unfiltered samples will be assumed to be total aluminum."* *"Dissolved aluminum" is defined as a sample that is filtered with a 0.45-μm membrane filter. The NDEP is more specific, requiring that "dissolved" be associated with a water sample that is field-filtered prior to acidification. (Note that "dissolved" is an operational definition, based on what portion of the sample passes through a 0.45-μm filter). Any sample that is acidified prior to filtering is considered by NDEP to yield "total" metals upon analysis.*	Thank you for your comment, text edited as suggested.	Section 2.1
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*4. Section 2.2, Pages 7-9. "Environmental Fate and Transport…" This section attempts to build on the information provided in Section 2.1. However, Section 2.2 seems to focus on the geochemical behavior of aluminum in the aqueous environment; specifically, solubility and speciation of dissolved aluminum. Figure 2 (page 9) shows the relative abundance of aqueous (i.e., dissolved) species through a range of pH values. Unfortunately, Figure 2 lists "Total Aluminum" on the y-axis; thereby adding to the confusion inherent in "dissolved" versus "total" discussion. The title on the y-axis should be changed to something like "Relative Percent of Dissolved Species." Figure 2 even seems to have confused one of the peer reviewers, who stated, "In Figure 2…aluminum in the water column at pH 7.0 is almost all in the insoluble form of aluminum hydroxide." NDEP believes this is incorrect; Figure 2 shows the relative abundance of dissolved species of aluminum at different pH values.* *Passage through a 0.45-μm membrane filter is the operational*	Figure 2 is provided in the document to give the reader an overall perspective of the solubility of aluminum over a wide pH range. As stated in the document, Figure 2 is taken verbatim from Zhou et al. (2008) and as described in the paper, Panel A of the figure illustrates the results of aluminum speciation of the total added to a saline solution in the absence of ligands. Thus the "Percent of Total Aluminum" displayed on the y-axis is relative to the total added, not percent dissolved relative to percent total. And the dotted lines indicate solutions that would be supersaturated with respect to freshly prepared $Al(OH)_3$, or the pH range in which the calculated concentration of $Al(OH)_3$ exceeds its solubility. At pH 7, the majority of the aluminum is as $Al(OH)_3$, and as observed by the authors, the insoluble $Al(OH)_3$ remained dispersed in solution as a labile, colloidal suspension (diameter of ≈400 nm). They also stated that true equilibration of aluminum solutions with the less soluble, crystalline form of $Al(OH)_3$ (gibbsite) would take months.	No edits.

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	definition for "dissolved" aluminum (and other dissolved metals). However, the true nature of "dissolved" is calculated based on the theoretical solubility of aluminum under a range of pH and chemical conditions, combined with reaction times needed to achieve equilibrium. Section 2.2 provides some discussion of how pH and the presence of complexing ions can affect the solubility of aluminum in natural waters. Throughout this discussion, the focus is on dissolved aluminum, and how pH and DOC can affect the amount of aluminum dissolved in water (which is why the criteria consider both pH and DOC). From the information provided in this section, the reader would expect the criteria to be based on dissolved aluminum; that reader would be wrong. *What is the purpose of considering pH and DOC, when the proposed 2017 criteria are based on total (i.e., dissolved and particulate) concentrations of aluminum?*	The "Environmental Fate and Transport" section of the document provides the reader with an overview of the chemistry of aluminum in the aquatic environment to compliment the information presented in Section 2.1. It is not meant to influence how the criteria are derived. The decision to base the criteria on total aluminum reflects a number of considerations (analytical procedure, bioavailability, etc.), all of which potentially impact implementation of the proposed criteria.	
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*6. Pages 12-14. The topic sentence of the last paragraph states that, "For fish, the gill is the primary site of aluminum toxicity under either acidic or alkaline conditions (Wilson 2012)." This follows the amphoteric nature of aluminum, suggesting that the criteria be based on dissolved aluminum. Likewise, on page 13, the text notes that the biotic ligand model (BLM), "…estimates the bioavailable portion of dissolved metals in the water column based on site-specific water quality parameters such as alkalinity, pH and dissolved organic carbon…" EPA (2017) opted instead to use a multiple linear regression model (MLR) because, although such "…models are less complex than BLM models, they also estimate the bioavailability of aluminum to aquatic species." This entire discussion seems to point to the "bioavailable portion of dissolved metals." Again, the document seems confused on the matter of "total" versus "dissolved."*	Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured.	Section 2.1 Section 2.6.2
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*7. <u>Pages 20-21</u>. The 2017 draft document states that, "The 1988 AWQC criteria for aluminum were based on <u>acid-soluble concentrations</u>, and were subsequently expressed in terms of <u>total recoverable aluminum</u>. The current EPA approved CWA Test Methods for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measure <u>total recoverable aluminum</u> (U.S. EPA 1994a, b). The 1988 criteria considered use of dissolved aluminum, but instead recommended acid-soluble aluminum..."* *The 2017 document needs a thorough review to eliminate such*	Thank you for your comment. Additional information has been added to clarify terminology used by USGS. In addition, text was edited to be consistent with identified terms.	Section 2.1 Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	contradictory statements regarding the nature of the 1988 criteria. Further, if standard ICP-AES and ICP-MS analyses actually measure "total recoverable aluminum" as stated on page 21 of the 2017 document, then it is likely that many states will have only data for "dissolved" (i.e., field-filtered prior to acidification) and "total recoverable" (i.e., unfiltered in the field prior to acidification and analyzed by ICP-AES or ICP-MS) aluminum. (Also, please note that "AWQC criteria" in the above quote literally states, "ambient water quality criteria criteria.")		
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*8. Page 21. The text discusses the relationship between concentrations described as "dissolved" and "total recoverable," versus toxicity. The fifth sentence of the last complete paragraph on page 21 states:* *"Toxicity was only observed when the test solutions were unfiltered; furthermore, dose-response was only observed using total aluminum as opposed to measurements of dissolved or monomeric forms (Gensemer et al. 2017)."* *The study cited (Gensemer et al. 2017) is not yet published and could not be found on-line. Therefore, the data on which this conclusion is based and the control (or lack thereof) of confounding variables are unknowns. Could it not be that the suspended particulates present in an unfiltered sample would have an adverse effect on the organisms tested? Were all other parameters accounted for? What is the mechanism by which the unfiltered portion of the water sample imparts toxicity? Is Gensemer et al. using "monomeric" as equivalent to "dissolved" or as a subset of "dissolved" species? Because "dissolved" is an operational definition only (i.e., that portion of the sample that will pass through a 0.45-µm membrane filter), was there any attempt to define particulate sizes that appeared to increase toxicity? Until these data and this study can be reviewed, the draft criteria cannot be properly evaluated.*	The Gensemer et al. (2018) study was available online pre-publication at the time of the draft release. It is now published hardcopy and addresses these questions. Gensemer, R., J. Gondek, P. Rodriquez, J.J. Arbildua, W. Stubblefield, A. Cardwell, R. Santore, A. Ryan, W. Adams and E. Nordheim. 2018. Evaluating the effects of pH, hardness, and dissolved organic carbon on the toxicity of aluminum to freshwater aquatic organisms under circumneutral conditions. Environ. Toxicol. Chem. 37(1): 49-60.	No edits.
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*10. Section 2.7.1, Pages 28-33. The discussion of the MLR model focuses on the solubility of aluminum (i.e., dissolved aluminum) and how it is affected by pH. The other factors (hardness and DOC) appear to modify the bioavailability of dissolved aluminum by cation competition ($Mg2+$, $Ca2+$) for binding to fish gills or reduction in toxicity when dissolved aluminum is bound by organic matter.*	As stated previously, the criteria are based on total aluminum to adequately address the bioavailability of aluminum in the environment and to also include colloidal and precipitated forms. Natural field samples are not typically used for toxicity testing due to the potential for other contaminants to be present, thereby exerting additional toxic stress on the test organisms.	No edits.

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	The focus of the discussion remains on dissolved aluminum, yet the new criteria specify use of data for total aluminum, as shown on Figures 4 and 5, against pH, which (as noted in the quote above) affects solubility of aluminum (i.e., dissolved species), and in Figures 6 and 7, against concentration of DOC and hardness, as well as pH. *"The negative pH2 term accounts for the fact that Al bioavailability decreases from pH 6 to pH 7 and then increases from pH 7 to pH 8, which is expected given the unique solubility chemistry of aluminum (DeForest et al. 2017)."* *The mechanism of toxicity associated with unfiltered samples of salt solutions prepared and tested in the laboratory is not adequately discussed in the 2017 criteria document. The 2017 document is internally inconsistent and needs extensive revision following toxicity testing using samples of field-filtered and unfiltered waters collected from streams and lakes.*	Additional information has been added to clarify terminology used. In addition, text was edited to be consistent with identified terms.	
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Terminology for measured Al* *The importance of thoroughly and accurately defining measured Al concentrations should be reviewed for clarity throughout the document. The draft criteria incorrectly states that all concentrations for toxicity tests are expressed as total recoverable Al. This is not correct in studies reported in Gensemer et al. (2017), Cardwell et al. (2017), Wang et al. (2017), including the European Aluminium Association and the Oregon State University references. These studies reported aluminum concentrations as "total Al" and not "total recoverable Al". The total Al analytical methodology used in these studies involved preserving an unfiltered sample with HNO3 to a pH of <2 prior to analysis, and does not include the additional digestion step used for "total recoverable". EPA should review and correct their references to "total Al" versus "total recoverable Al." This will also have implications in criteria/standards implementation.*	The commenter is correct, the studies noted should be described as concentrations for toxicity tests are expressed as total Al, not total recoverable Al. Gensemer et al. (2018): Total Al (acidified to pH <2 prior to analysis); Cardwell et al. (2018): Total Al (acidified to pH <2 prior to analysis); Wang et al. (2018): Total Al (acidified to pH <2 prior to analysis); European Aluminium Association (2009): Nominal concentrations equate to total Al; European Aluminium Association (2010): Nominal and Total concentrations, don't specify method for total Al; Oregon State University (2012a,b,c,d,e,f,g,h & 2013): Total Al (acidified to pH <2 prior to analysis, although reports incorrectly state that sample collected for total recoverable analysis).	No edits.

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 3* Sentence*: The terms filtered, dissolved, unfiltered, and total and their relationships are defined below.* Comment*: This sentence should be modified (see general comments on terminology). Sentence should include the term "acid-soluble" as this terminology is used in the 1988 criteria document (i.e., acidify the water sample with* HNO_3 *to pH 1.65-1.85, followed by filtration through 0.45 µm). Also the differentiation between "total" and "total recoverable" should be mentioned.*	Thank you for your comment. Additional information has been added to clarify terminology.	Section 2.1
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Chemistry of Aluminum* *One of the central problems with the extrapolation of laboratory toxicity data with aluminum to regulatory criteria implementation in natural waters is the complex chemistry of precipitated or solid-phases of aluminum. As EPA correctly summarizes on page 22, natural waters contain mineral particulate forms of aluminum that may be subject to measurement "uncertainty" when using "total recoverable" [As per typical analytical methods for total recoverable metal, the term "total recoverable" should only be applied to samples that have been acidified by HNO3 and HCl, followed by gentle fluxing (see Table 7 of Cardwell et al. 2017)] forms of aluminum. While this is an accurate statement, EPA does not fully explain this uncertainty in terms of how aluminum criteria should be applied, or even how the toxicity data presented in the criteria document should be cited or interpreted. These are critical omissions that would benefit from further explanation as EPA revises the aluminum criteria. Specific aspects of this concern are outlined below.* • *On page 22, EPA states that "All concentrations for toxicity tests are expressed as total recoverable aluminum in this document (unless otherwise specified), and not as the form of the chemical tested." This is generally not correct—for most all of the laboratory studies we've conducted or reviewed, total recoverable metal assays were not used to express the total concentration of Al in the test solutions. Rather, most tests used a "total" aluminum assay which was simply the acidification of unfiltered test solutions without the additional digestion/fluxing step used in total recoverable analytical methods. The simpler "total" aluminum assay is appropriate for laboratory test solutions (as correctly*	Thank you for highlighting these discrepancies; these errors were corrected. The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations.	Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	pointed out by EPA on page 69) that only contain dissolved monomeric and precipitated forms (e.g., aluminum hydroxides) of aluminum. This simpler total metal assay should indeed solubilize any precipitated forms of aluminum, thereby leading to an accurate measure of all aluminum forms in the test solutions. Therefore, EPA should not use the terminology of "total recoverable" aluminum in the context of laboratory tests unless they are certain the study actually used this more aggressive analytical method. • *On page 69, EPA correctly cites justifications for use of "total" aluminum concentrations in laboratory tests based on work presented in Gensemer et al. 2017 and Santore et al. 2017. However, in this discussion, EPA incorrectly uses the term "particulate" to describe the other basic form of aluminum considered in Santore et al. 2017 in addition to dissolved aluminum. In an important distinction, Santore et al. 2017 uses the term "precipitated" aluminum to refer to aluminum hydroxides that precipitate in the test solutions when concentrations and pH are such that solubility of the dissolved metal is exceeded. The other papers in this journal series (e.g., Cardwell et al. 2017 and Gensemer et al. 2017) also are careful to use the term "precipitated" aluminum to distinguish solid phase aluminum that forms specifically in test solutions following precipitation of the dissolved (usually acidic) concentrated stock solutions at circumneutral pH. The term "particulate" can too easily be confused with mineral particulates in natural waters, so we suggest that EPA use the term "precipitated" aluminum in this context.* • *Overall, we suggest that EPA do more to explain the "uncertainty" with respect to total or total recoverable aluminum measurements in natural waters. While EPA correctly points out on page 69 that total (should be total recoverable here) concentrations "may overestimate the potential risks of toxicity…", further explanation is warranted to ensure that implementation of these criteria do not generate too many false positive outcomes (i.e., total recoverable aluminum concentrations that exceed the criteria, but the true bioavailable concentration of aluminum would not exceed the criteria). A more clear*	This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters.	

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	understanding of this uncertainty would assist States and Tribes as they seek to develop the best methods or implementation tools to ensure the criteria are used and interpreted in the most accurate way possible. For example, New Mexico uses a coarse (e.g., 10 micron) filtration step to remove at least some of the non-toxic mineral phase aluminum as stated in their water quality standards: "For aluminum, the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize mineral phases as specified by the department." (see NMAC 20.6.4.900.H) • *Although coarse prefiltration presents a possible solution, analytical methods based on a mild acid-reactive process would likely provide a more accurate representation of bioavailable aluminum in waters with significant amounts of mineral particulates because of the operational nature of size-based filtration methods. In particular, methods that use a less strong or aggressive acidification step than that used in a total recoverable metal assay would likely provide a more accurate measure of bioavailable aluminum in natural waters. Such methods might include the acid soluble test described in the existing national aluminum criteria (EPA 1988), or even a modified pH 4 extraction method currently under development. We recognize that these methods are not yet available for compliance purposes under the Clean Water Act in all cases. However, until such time as an improved method is available (e.g., the modified pH 4 method), we suggest that EPA consider citing the acid-soluble method (EPA 1991; method 200.1) as the recommend method for implementation as they did in the existing 1988 criteria. At the very least, we feel a more thorough discussion of the uncertainties regarding the use of total recoverable aluminum concentrations in natural waters would great help end users of these criteria.*		

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 4* *Sentence: Groundwater concentrations of dissolved aluminum (filtered using a 0.45 micrometer filter) from the NAWQA database collected during 1992-2003 are presented in **Figure 1**, with a 90th percentile concentration of dissolved aluminum concentrations of 11 µg/L.* *Comment: Is 2003 the most recent data collection of groundwater data? Could this be expanded to more current values?*	The figure is the latest and most up to date figure available.	No edits.
EPA-HQ-OW-2017-0260-0028 *(Joshua D. Schimmel, Executive Director, Springfield Water and Sewer Commission (SWSC))*	*1. The SWSC suggests clarification of the phrase "site-specific values" by clearly stating that water quality parameters should be collected from the receiving water.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion.	No edits.
EPA-HQ-OW-2017-0260-0035 *(Richard A. Hyde, P.E., Executive Director, Texas Commission on Environmental Quality (TCEQ))*	***D. The TCEQ recommends EPA be clear and consistent regarding the speciation of aluminum.*** *The speciation of aluminum in the 1988 criteria document is referenced inconsistently in EPA's current proposal. EPA should clarify the speciation, and reference the information consistently. For example, the following citations in EPA's current proposal inconsistently reference aluminum speciation of the 1988 criteria:* • *Page xii: "The 1988 aluminum freshwater acute criterion was based on dissolved aluminum concentrations..."* • *Page 20-21: "The 1988 AWQC criteria for aluminum were based on acid-soluble concentrations, and were subsequently expressed in terms of total recoverable aluminum."* • *Page 21: "The 1988 criteria considered use of dissolved aluminum, but instead recommended acid soluble aluminum for several reasons."* • *Page 74: Table 9, Summary Overview of 2017 Draft Aluminum Aquatic Life Criteria Compared to Current 1988 Criteria references aluminum concentrations for both criteria documents as "total aluminum".*	Thank you for your comment. Additional information has been added to clarify terminology. In addition, text was edited to be consistent with identified terms.	Section 2.1 Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*5. Pages 10-11. Sentences within one paragraph (split between pages 10 and 11 of the draft criteria document) appear to state opposite results and conclusions. On page 10, the second sentence of the last paragraph states "Over time as the aluminum from the stock solution equilibrates with the test water and the pH increases, the monomeric species of aluminum transform to the insoluble polymeric hydroxide species, which are more toxic…" This seems to indicate that precipitates (i.e., insoluble forms) in older solutions have higher toxicity than the dissolved (i.e., soluble) species of aluminum. However, the next two sentences state that "…soon after test initiation, there is a transformation period of rapid speciation changes from short-lived transient amorphous and colloidal forms of aluminum to more stable crystalline forms (Gensemer et al. 2017). Aged stock solutions (aluminum solutions that have been given time to form more stable forms of aluminum) have been shown to be less toxic than those that are not aged." Readers will likely imagine that "soon after" occurs faster than "over time," and will equate "over time" with "aged." One sentence says aged is "more toxic" and one says it is "less toxic." Is this poorly stated or misstated? Which qualifier (i.e., "more" or "less") for toxicity is correct?*	Thank you for your comment, text was edited for clarification.	Section 2.3
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*9. Section 2.7.1, Page 27. Please define "short-term aluminum chronic toxicity data." "Chronic" defines a long-term condition. What is difference between standard testing for chronic toxicity and the testing for short-term chronic toxicity? Are the data from short-term tests of chronic toxicity for aluminum different from data from standard chronic tests?*	As described on page 27 (Section 2.7.1), the "short-term chronic tests" refer to the 7-day fathead minnow, 7-day *C. dubia* and 72-hr algal (*Pseudokirchneriella subcapitata*) tests. Standard chronic tests for invertebrates and fish usually span the life cycle of the species, although 7-day *C. dubia* and 28-day early life stage fish tests are routinely used in the sensitivity distribution for criteria derivation. Algal tests should be 96 hours as recommended by the Guidelines.	No edits.
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*7. "Hardness" is used interchangeably with "Total Hardness" and it is difficult to tell without investigating all the subtending literature if these are being differentiated. Total Hardness is the parameter used in the 2017 Al guidance calculator. However, New Mexico's hardness-dependent calculator for compliance with hardness-dependent numeric criteria, uses dissolved hardness (as mg CaC03/L). This discrepancy made it difficult to accurately assess New Mexico's EPA approved hardness-based criteria against the proposed guidance.* **Can it be demonstrated that particulate hardness (solid phase hardness included in the MLR model inputs) provides protection of aquatic life***?*	Thank you for your suggestion. To avoid confusion, "total" was added throughout the document. Currently there is no data available comparing the dissolved versus particulate hardness for aluminum.	Throughout the document, appendices and the Aluminum Criteria Calculator.

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0045 *(Lee Lemke, Executive Vice President, Georgia Mining Association (GMA))*	*3) In the Review Comments, Reviewers 2 and 4 repeatedly emphasize the enormous disparity between the solubilities of the aluminum forms used in the Draft Criteria's referenced experiments compared with aluminosilicate minerals. Reviewer 4 states:* *"The current text does explain soluble speciation (i.e., complexation) but fails to recognize solid speciation. There is a large difference between a particle of feldspar or kaolinite from freshly precipitated aluminum hydroxide" (p. 41, Review Comments).* *Despite the frequency and reasonableness of these comments,* ***the authors of the Draft Criteria inadequately address these review comments by simply adding language to the brief treatment of uncertainty*** *in the Draft Criteria, while offering no suggested recourse to this problem.*	The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has recently been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters.	Section 2.6.2
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	***Use of analytical methods and terminology for measuring aluminum concentrations*** *As stated on page 22 of the revised criteria document, natural waters contain mineral forms of Al that may not be bioavailable, therefore aggressive digestions (such as total recoverable methods) may lead to potential overestimations of bioavailable Al in natural waters containing suspended solids.* *Both the type of analytical method used and the terminology for measured Al as it relates to the expression of water quality criteria should be more clearly defined and applied throughout the draft criteria document. To address the issues of appropriate analytical methodology for measuring Al in natural waters, our research group is currently developing methods that will be helpful in measuring the amount of "bioavailable" Al in natural waters (pH 4 digestion in Table 1). For clarity, we have provided Table 1 to summarize and further define all of the available methods.* *We believe a clearer description of both analytical methods and analytical terminology would allow users to effectively quantify Al concentrations in natural waters. A more robust discussion on measuring Al in natural waters would also provide guidance on appropriate ways to measure bioavailable Al and avoid measuring non-toxic mineral phases.* *[TABLE 1]*		

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xi (Executive Summary)* *Sentence: Multiple linear regression (MLR) models were developed to characterize the bioavailability of aluminum in aquatic systems based on the effects of pH, hardness and DOC (DeForest et al. 2017). The authors used 22 chronic tests with the fathead minnow (Pimephales promelas), and 23 chronic tests with Ceriodaphnia dubia to evaluate the ability of MLR models to predict chronic toxicity of aluminum as a function of multiple combinations of pH, hardness, and DOC conditions.* *Comment: The Agency failed to mention that the MLR approach included many studies with green algae as well. While the Agency does not use these values in their approach to criteria development, the data provide support for the overall MLR approach as presented in DeForest et al 2017. Reference to the algae data would be appropriate.*	Since this plant MLR model was not used in the criteria development it is not needed in the Executive Summary. The plant MLR model is discussed in Section 2.7.1 and text has been edited to present the plant MLR model in Section 5.2. The EPA discussed that, based on existing data, plants are less sensitive then fish and invertebrates, thus the 2018 aluminum criteria is expected to be protective of aquatic plant species.	Section 5.2.
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xii* *Sentence: The 1988 aluminum freshwater acute criterion was based upon dissolved aluminum concentrations.* *Comment: It is not correct that those criteria were based on dissolved aluminum. Criteria were stated on the basis of "acid-soluble" measurements.*	Thank you for your comment. The sentence has been edited. The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum.	Executive Summary
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xii* *Sentence: The MLR equations applied to the acute toxicity data were those developed through chronic tests, with the assumption that the effect of water chemistry on bioavailability remains consistent.* *Comment: This statement should be expanded a little to indicate that the MLR approach published by DeForest et al. (2017) was developed using chronic tests and the Agency adopted these to develop equations for acute testing.*	Thank you for your comment. The final 2018 aluminum criteria document discusses application of the chronic MLR approach to normalize acute data.	No edits.

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EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xiii* *Sentence: This 2017 draft criteria update includes new data…* *Comment: This should read - This 2017 draft criteria update includes new acute and chronic data. And, "Minimum Data Requirements (MDRs) for direct calculation" should read - Minimum Data Requirements (MDRs) for direct calculation without the use of an acute to chronic ratio.*	Text was edited for clarity.	Executive Summary
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xiii, lines 20-22* *Comment: It would be quite insightful if the Agency were to include a MLR calculation of the water chemistry that results in a CCC value of 87 µg/L, i.e., DOC, 1 mg/L, hardness 50 mg/L and pH 6.27 (using the MLR published by DeForest et al.)*	Since the chronic criterion (CCC) is a function of three water quality parameters (pH, total hardness and DOC), there are multiple scenarios where the CCC would be ~87 µg/L (the 1988 AWQC CCC). For example, in Appendix K, Table K-1 where the DOC=0.1 mg/L, the CCC would be 87 µg/L when the pH=6.5 and total hardness=150 mg/L. Another example would be Table K-8 (DOC=2.5, pH=6.0 and total hardness=10) where the CCC=81 µg/L.	No edits.
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page xiv (and throughout)* *Comment: It would be beneficial for the Agency to provide a basis for the water quality characteristics "example" (pH = 7, hardness = 100 mg/L, DOC =1 mg/L) that is used throughout the document as an example of a normalized value. Does the agency believe these water quality characteristics are of a typical North American natural water? For background and because it is significantly used throughout the document, please provide a basis for selecting these specific values.*	The water quality characteristics that the EPA uses a scenario throughout the document was simply an example scenario. In other hardness based AWQC documents (i.e., cadmium), total hardness is usually normalized to a hardness of 100 mg/L as $CaCO_3$. The sample DOC and pH was chosen just to be illustrative of one example scenario. Additional text added to clear up this confusion and to relate that the sample scenario is just an example. The calculator allows a wide range of water quality conditions typical of US waters to be taken into consideration in deriving criteria.	Executive Summary (table insert) Section 2.7.1 Table 9
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 5* *Sentence: At the typical ocean pH of 8.0-8.3, aluminum coordinates with the hydroxide ion, primarily as Al(OH)4.* *Comment: Suggest revision: At the typical ocean pH of 8.0-8.3, aluminum coordinates with the hydroxide ion, primarily as Al(OH)4, which will precipitate out of solution, for the most part, which explains the low concentrations in marine waters.*	Thank you for your suggestion, text was edited.	Section 2.1

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 6, second last paragraph* *Comment: some mention of the impact of soil particles entrained in the air samples should be mentioned. Total analyses will digest the particles which are typically high in Al. Air Al concentrations are highly dependent upon particulate concentrations.*	Thank you for your suggestion, text was edited.	Section 2.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 7* *Sentence: In streambed sediment samples collected from locations in the conterminous U.S. from 1992 to 1996, aluminum concentrations ranged from 1.4 to 14 µg/g dry weight (Rice 1999).* *Comment: Are the units correct – µg/g (i.e., ppm)? More likely 1.4 - 14%. Soil samples range from 500-142,000, hence, stream bedded sediments would be quite similar.*	Thank you for your suggestion; the correct values are weight percent, text was edited.	Section 2.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 9 first sentence;* *Sentence:...characteristics are significant because episodic acidic pulses in streams, for example during winter snowmelt, maximize the solubility of aluminum* *Comment: Edit text…characteristics are significant because episodic acidic pulses in streams, for example during winter snowmelt, maximize the solubility of aluminum if pH drops to 5.5 or lower.*	Thank you for your suggestion; the text was edited.	Section 2.2
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 10, second paragraph* *Sentence: Freeman and Everhart (1971) found that the chronic toxicity of nominal (unmeasured) aluminum increased as pH increased from 6.8 to 8.99 in rainbow trout."* *Comment: Does this mean that the toxicity values became smaller?*	Aluminum was more toxic at the higher pH when exposed to same concentration of aluminum (TL_{50} was 38.9 days at pH 6.8 compared to TL_{50} of 2.96 days at pH 8.99). Text was edited for clarity.	Section 2.3

Comment Number (Organization)	Public Comment on Topic 8: Regarding the document in general	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 12* *Sentence: Bottom-dwelling organisms may be impacted more by aluminum floc in the field than in the laboratory due to the greater floc layer thickness observed in the field relative to laboratory exposures.* *Comment: This depends upon the water velocity/mixing zone/movement of water in both the field and lab. Please clarify or provide citation for this observation.*	Thank you for your suggestion; the text was edited.	Section 2.3
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 12* *Sentence: Bioavailability of aluminum is affected by water chemistry parameters such as pH, hardness, and DOC.* *Comment: Text edit needed. Bioavailability of aluminum is affected by water chemistry parameters such as pH, hardness, and DOC* ***and to a lesser extent fluoride****.*	Thank you for your suggestion; the text was edited	Section 2.3.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 13* *Sentence: Overall, aquatic plants are generally insensitive to aluminum. Algae productivity and biomass are seldom affected if the pH is above 3.0. Aluminum and acid toxicity tend to be additive to some algae when the pH is less than 4.5.* *Comment: Gensemer et al. (2017) demonstrated toxicity to the green algae under varying pH, hardness, and DOC conditions. Suggest clarification to the statement that algae biomass are seldom affected if the pH is above 3.0.*	Thank you for your suggestion; the text was edited.	Section 2.3
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 13, second last paragraph* *Sentence: In contrast, no apparent hardness-toxicity relationship was observed for rainbow trout exposed to three different hardness levels at a controlled pH of 8.3 (Gundersen et al. 1994).* *Comment: This is consistent with data recently published by DeForest et al (2017) and Gensemer et al (2017) demonstrating that there is a reduced effect of hardness at elevated pH levels.*	Thank you for your suggestion; the text was edited	Section 2.3.1

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EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 13 and 14* *Sentence: Paragraph starting with "Development of the "biotic ligand model" (BLM - formerly the "gill model")* *Comment: We suggest mentioning and/or discussing how the Al BLM differs from earlier BLMs with other metals, as the Al BLM accounts for the dissolved and precipitated fraction.*	Thank you for your suggestion; the text was edited	Section 2.3.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 21* *Sentence: The 1988 criteria considered use of dissolved aluminum, but instead recommended acid-soluble aluminum for several reasons.* *Comment: Correct. Suggest this edit to page xii as well.*	Thank you for your suggestion; the text was edited	Executive Summary
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 27* *Sentence: These three parameters are thought to be the most influential for aluminum bioavailability and can be used to explain the magnitude of differences in the observed toxicity values (Cardwell et al. 2017).* *Comment: The more correct citation for this would be Gensemer et al. (2017) and Cardwell et al. (2017).*	Thank you for your suggestion; the text was edited	Section 2.7.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 34* *Sentence: Throughout this document, unless otherwise stated, effect concentrations were normalized to pH 7, hardness of 100 mg/L and DOC of 1 mg/L. These specific values were chosen to represent pH, hardness and DOC levels found in the environment.* *Comment: This sentence about the selection of these specific values as an example is vague. Additional basis for use as an example would be appreciated.*	The water quality characteristics that the EPA uses as a scenario throughout the document were simply an example scenario. In other hardness based AWQC documents (i.e., cadmium), total hardness is usually normalized to a hardness of 100 mg/L as $CaCO_3$. The sample DOC and pH was chosen just to be illustrative of one example scenario. Additional text added to clarify that the sample scenario is just an example.	Section 2.7.1

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EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 49* *Sentence: Oregon State University also conducted several chronic studies for three invertebrate species: an oligochaete, Aeolosoma sp.; a rotifer, Brachionus calyciflorus; the great pond snail, Lymnaea stagnalis; and one fish species, an early life cycle test with the zebrafish (OSU 2012b,c,e, 2013).* *Comment: The one fish species (zebrafish) should be under the vertebrate section and not the invertebrate section.*	Thank you for your suggestion; the write up for this study was moved to the vertebrate section.	Section 3.2.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 49 (and Appendix C spreadsheet)* *Sentence: pond snail 30-day biomass* *Comment: The snail (Lymnaea stagnalis) study reported by OSU and Cardwell et al. (2017) did not calculate a biomass endpoint (survival and wet weight were calculated and reported). If additional analysis was conducted by EPA to report a biomass endpoint, please provide details for clarity.*	Biomass was calculated using the reported values in Table 3-8 (OSU 2012b) by calculating proportion survived by wet weight. If aluminum reduced survival and growth, the product of these variables (biomass) was analyzed (when possible), rather than analyzing them separately.	No edits.
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 50* *Sentence: The chronic toxicity of aluminum to fathead minnows was also evaluated by OSU (2012g). Very similar exposure methodology and the same dilution water were used as described above for the amphipod and midge tests (OSU 2012f, h), except that <24-hr old fertilized eggs were used at initiation of the 33-day test.* *Comment: Suggest revision as the only similar methodology was the dilution water and pH control of the water. The methods for number of replicates, feeding, duration, flow-rate, etc. were all different from the amphipod and midge. Suggest citation to Cardwell et al. (2017) which details methodologies for each species.*	Text was edited for clarity.	Section 3.2.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 50* *Sentence: Fry survival was the most sensitive endpoint with an estimated EC20 of 428.6 µg/L, and normalized EC20 of 1,734 µg/L.* *Comment: Suggest edit (adding calculated). Fry survival was the most sensitive endpoint with a calculated EC20 of 428.6 µg/L, and normalized EC20 of 1,734 µg/L.*	Text was edited for clarity.	Section 3.2.1

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EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 51* *<u>Sentence</u>: The NOEC for survival and growth normalized to a pH 7, hardness of 100 mg/L and DOC of 1.0 mg/L was 9,746 µg/L (the highest concentration tested), with a chronic value of >9,746 µg/L.* *<u>Comment</u>: Suggest removal of "highest concentration tested" as this was not the highest exposure tested (appears the actual concentration was 2,000 µg/L).*	Text was edited as suggested.	Section 3.2.1
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Page 70* *<u>Sentence</u>: Both MLR models and the BLM model are based on the same toxicity test database.* *<u>Comment</u>: Both models include the same toxicity test data, but the BLM doesn't exclusively use the data (BLM includes data on the accumulation of Al on the gills of salmon). This is somewhat clarified in the next sentence, but we suggest the sentence that both models are based on the same database should be re-worded.*	Thank you for your suggestion; the text was edited.	Section 5.3.5
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*Appendices B, E, G, H* *<u>Comment</u>: Suggest EPA provide separate column for DOC concentrations, as was done in Appendix A and C.*	Thank you for your suggestion. The EPA chose not to add this column. Regarding Appendix B (Acceptable Acute Toxicity Data of Aluminum to Estuarine/Marine Aquatic Animals) and Appendix E (Acceptable Toxicity Data of Aluminum to Freshwater Aquatic Plants), these studies often did not report DOC and there were not enough data to develop criteria for estuarine/marine aquatic animals and plants. Appendix G (Acceptable Bioaccumulation Data of Aluminum by Aquatic Organisms) data was not used in criteria derivation. Appendix H (Other Data on Effects of Aluminum to Freshwater Aquatic Organisms) contains data that are not used in the criteria derivation because they were not of sufficient quality.	No edits.
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*(M) The draft criteria document states that a total of 7,483 surface samples were collected and analyzed for dissolved and total aluminum. The EPA should describe what fraction of the Total Aluminum measured in these samples was in a form that was likely to become bioavailable under natural conditions and what fraction was in the inert, insoluble form previously acknowledged as "not biologically available." [DAC @ pg. 69]*	The Water Quality Data Portal does not describe what fractions of these samples are bioavailable, thus, we are unable to provide this information.	No edits.

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EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	*5. **<u>EPA should be explicit that the criteria are site-specific.</u>** UWAG recommends that EPA clearly state that the criteria, when finalized, should be applied on a site-specific basis. In several locations of the Draft Criteria, EPA states that site-specific measurements of these parameters provides the greatest certainty of protection:* *"Like the acute criterion, the freshwater chronic criterion, known as the Criterion Continuous Concentration (CCC), is also dependent upon the set of water chemistry conditions at the site."* *Draft Criteria at xiii. As the criteria are derived based on site-specific parameters, they logically are applicable on a site-specific basis as EPA recognizes.*	The criteria can be applied on a site-specific basis, and a state could choose to apply them on another basis, such as an ecoregional basis by using water chemistry input data that would appropriately represent the area selected and the designated use for those waters.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Other Items*** *Below are additional areas we have identified within the draft criteria document which would benefit from correction or clarification from EPA.* • *In Section 2.7.1 (p 27) the test conditions of the P. subcapitata studies evaluated for the MLR as listed may not be correct.* • *The range of DOC concentrations tested is given as "0.-1.9mg/L." The algae results presented in Gensemer et al. 2017 show the range of DOC concentrations tested were 0.3 to 4.0 mg/L.*	Thank you for your suggestion; the text was corrected.	Section 2.7.1
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*3. <u>Page 4</u>. The last paragraph on this page reports that data obtained from the "Water Quality Data Portal." The range of concentrations reported for dissolved aluminum is from 0.8 micrograms per liter to 20,600 micrograms per liter. The latter value is provided without qualification, even though it far exceeds the equilibrium solubility of aluminum in most natural waters. This is misleading. If the 20.6 milligrams per liter value was from acid mine drainage, the number would make sense; however, this is not mentioned. The concluding sentence of this paragraph reports that the 90th percentile for concentrations of dissolved aluminum in groundwater is 11 micrograms per liter; this does make sense for the typical range of pH values for natural waters, but there is no mention of the relation to surface waters. The final sentence also refers the reader to Figure 1, which provides a range of concentrations for dissolved aluminum in **groundwater**. Discussion is needed to put these numbers in context for the reader.*	The Water Quality Data Portal did not provide enough information to clarify if this is the case. This is the available data from the Water Quality Data Portal.	No edits.

TOPIC 9: Comments regarding the Endangered Species Act

Comment Number (Organization)	Public Comment on Topic 9: Regarding the Endangered Species Act	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	***2. National consultation for Endangered Species Act*** *EPA continues to issue revised water quality criteria without developing the biological evaluations and consultation of the effects of criteria levels on endangered species as required under the Endangered Species Act (16 U.S.C. 1531-1544). EPA consultations done after state adoption of criteria can delay EPA approval of state criteria for years. ADEC strongly urges EPA to complete ESA consultation before issuing final criteria. National ESA consultation prior to publishing final criteria would be most effective in protecting endangered species and would alleviate further burden on states and delays in EPA action on state water quality standards.*	The Endangered Species Act does not require EPA to develop a biological evaluation and consult with the Services on water quality criteria developed under CWA Section 304(a). Ambient water quality criteria are recommendations and do not impose legally binding requirements on states to adopt these specific criteria recommendations, nor do they bind the Agency to take future federal action with respect to state standards that are less, more, or equally stringent than the recommended value. States are not required to adopt the national recommended criteria. Thus, by developing national recommended criteria, EPA is not authorizing, funding, or carrying out an agency action subject to the ESA. In addition, recommended 304(a) criteria are not reviewable final agency actions. EPA's statement in the 2011 Memorandum of Agreement does not create a binding requirement for the Agency to engage in ESA consultation. That agreement states that the "memorandum is intended only to improve the internal management of EPA and the Services and is not intended to, and does not, create any right or benefit, substantial or procedural, enforceable at law or equity by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person". 66 Fed. Reg. 11202, 11217 (Feb. 22, 2001). Further, endangered species have not been found to be more toxicologically sensitive than other species, based on available data. The distribution of any particularly sensitive listed species which might affect the appropriate local water quality criteria is location specific; Allowing the most sensitive location-specific potential concerns to determine national recommendations, including for locations where especially sensitive endangered species are not present, would tend to inappropriately bias those recommendations. The EPA believes that it is most efficient for states to modify national criteria recommendations for aluminum, if necessary, based on the presence of any localized highly sensitive species-specific concerns or use other scientifically defensible methods when adopting new or revised water	No edits.
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*EPA's duty to complete its Section 7 consultation process prior to finalizing any recommended criterion is firmly established by the text of the ESA and by the Memorandum of Agreement that EPA entered with the Services to clarify the procedures for ESA compliance in taking action under the CWA. The latter document states that:* *EPA and the Services will conduct a section 7 consultation on the aquatic life criteria to assess the effect of the criteria on listed species and designated critical habitat. EPA and the Services will also conduct a conference regarding species proposed for listing and proposed designated critical habitat. EPA will consider the results of this consultation as it implements and refines its criteria program, including decisions regarding the relative priorities of revising existing criteria and developing new criteria. [Memorandum of Agreement Between the Environmental Protection Agency, Fish and Wildlife Service and National Marine Fisheries Service Regarding Enhanced Coordination Under the Clean Water Act and Endangered Species Act at 11 (Jan. 2001)].* *EPA asserts that the meaning of water quality criteria in Section 304(a)(1) of the CWA, is "a non-regulatory, scientific assessment of ecological and human health effects."[DRAFT AQUATIC LIFE AMBIENT WATER QUALITY CRITERIA FOR ALUMINUM 2017 (hereafter "DRAFT CRITERIA") at 4. Docket #: EPA-HQ-OW-2017-0260-0002]. However, EPA also correctly notes that these:* *If water quality criteria associated with specific surface water uses are adopted by a state or EPA as water quality standards under*		

Comment Number (Organization)	Public Comment on Topic 9: Regarding the Endangered Species Act	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	section 303, they become applicable Clean Water Act water quality standards in ambient waters within that state or authorized tribe. Water quality criteria adopted in state water quality standards could have the same numerical values as criteria developed under section 304. However, in many situations states might want to adjust water quality criteria developed under section 304 to reflect local environmental conditions and human exposure patterns. [Id]. *The establishment of water quality criteria under Section 304(a)(1) is an action for purposes of Section 7 because such criteria set the ceiling for establishment of water quality standards. Even if water quality criteria are not regulatory per se, like a Forest Management Plan under the National Forest Management Act or similar federal agency acts, consequences still flow from the establishment of the criteria. The federal act of establishing these criteria has both direct and indirect effects for species, especially since methodologies are chosen and species get excluded from consideration now with consequences for how states may proceed in establishing water quality standards. Additionally, criteria for toxic pollutants under Section 303(b) are less "optional" than criteria developed for non-toxic pollutants. This makes the adoption of criteria for toxics certainly more "regulatory" in nature.*	quality standards under CWA section 303(c). When appropriate, the EPA intends to consult with the Services regarding future approvals of new or revised state water quality standards under Clean Water Act Section 303(c) per the Endangered Species Act requirements.	
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*Because of the incredibly endangered status of many freshwater mussels in the United States, it is simply unacceptable for EPA to ignore the input of experts in the Fish and Wildlife Service to set a protective criterion for freshwater mussels. The reality is that the EPA lacks the capacity and ability to take action that is protective of endangered species. If EPA finalizes this criterion without consultations, the Center will take legal action to remedy this gross deficiency.* *EPA also has an independent obligation under Section 7(a)(1), to "carrying out [its] programs for the conservation of endangered species and threatened species."[16 U.S.C. § 1536(a)(1)]. By consulting on national criteria and coordinating with the Services, EPA can move toward meeting its Section 7(a)(1) obligations.* *The Clean Water Act mandates that water quality standards protect not only fish, but all aquatic organisms and other wildlife that depend on healthy streams. Section 303(c) requires that such standards "shall be established taking into consideration their use*	In response to concerns raised by the USFWS, and others, that endangered freshwater mussels may be sensitive to aluminum, the EPA included recent studies by USGS on freshwater mussels, the fatmucket mussel (*Lampsilis siliquoidea*), in the family Unionidae in the 2018 aluminum criteria derivation. Freshwater mussels in the family Unionidae are known to be sensitive to a number of chemicals, including metals and organic compounds (Wang et al 2018; U.S. EPA 2013). While the 96-hr LC_{50} juvenile test included in the criteria document failed to elicit an acute 50% response at the highest concentration tested (6,302 µg/L total aluminum, or 29,492 µg/L when normalized), the 28-day biomass normalized SMCV ranked as the <u>fourth</u> most sensitive genus in the dataset. The mussel's chronic value is greater than the most sensitive species, Atlantic salmon, and the freshwater criterion. Thus, the chronic criterion is expected to be protective of freshwater mussels and related species. The	No edits.

Comment Number (Organization)	Public Comment on Topic 9: Regarding the Endangered Species Act	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	and value for . . . propagation of fish and wildlife," among other things.[33 U.S.C. § 1313(c)(2)(A) (emphasis added); see also id. § 1252(a) (directing states to develop comprehensive programs for controlling water pollution giving due regard to improvements necessary to "conserve such waters for the protection and propagation of fish and aquatic life and wildlife").] EPA's regulations require states to develop standards that will "[s]erve the purposes of the Act," meaning that they will "provide water quality for the protection and propagation of fish, shellfish and wildlife," among other things.[40 C.F.R. § 130.3].	fatmucket mussel tested is not a threatened and/or endangered species, but the genus *Lampsilis* contains several listed species with a wide distribution across the United States. Additional testing on endangered mussel species, or closely related surrogates, would be useful to further examine the potential risk of aluminum exposures to endangered freshwater mussels. The EPA believes that it is most efficient for states to modify national criteria recommendations for aluminum, if necessary, based on the presence of any localized highly sensitive species-specific concerns or use other scientifically defensible methods when adopting new or revised water quality standards under CWA section 303(c). When appropriate, the EPA intends to consult with the Services regarding future approvals of new or revised state water quality standards under Clean Water Act Section 303(c) per the Endangered Species Act requirements.	
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*The Fish and Wildlife Coordination Act ("FWCA") gives the U.S. Fish and Wildlife Service ("FWS") broad authority to protect freshwater wildlife resources through coordination and providing assistance to all federal agencies regarding actions that may impact U.S. waters.[16 U.S.C. § 661 et. seq]. To ensure that the final aluminum water quality criteria is fully protective of all types of wildlife, EPA should engage the FWS broadly — not just as is clearly legally required by the ESA — but also engage other divisions of the FWS that may have additional expertise and information that would benefit the EPA.* *Congress expected that the EPA would develop water quality criteria with input from the FWS and other federal agencies. At its outset, Section 304(a) states "The Administrator, after consultation with appropriate Federal and State agencies and other interested persons, shall develop and publish" water quality criteria.[33 U.S.C. § 1314(a)(1)]. Furthermore, Section 511 of the CWA, affirms that the CWA does not limit or preclude this type of coordination under the FWCA.[33 U.S.C. § 1371]. In passing the original CWA, the House and Senate proposed different versions of Section 511. The Senate version would have limited "the consultation and coordination requirements of the Fish and Wildlife Coordination Act . . . to the provisions of section 306, the publication of information under section 304 and the establishment*	The EPA disagrees that before making general recommendations to states regarding future state actions to adopt aluminum criteria ("national recommendations"), it is helpful or necessary to first engage in consultation under the ESA to ensure that any possible subsequent federal action to approve new or revised state aluminum criteria consistent with the national recommendations would be protective of listed species. The national criteria recommendations for aluminum do not impose legally binding requirements on states to adopt these specific criteria recommendations, nor does it bind the Agency to take future federal action with respect to state standards that are less, more, or equally stringent than the guidance value. States are not required to adopt the national recommended criteria. Thus, by developing national recommended criteria, EPA is not authorizing, funding, or carrying out an agency action subject to the ESA. In addition, recommended 304(a) criteria are not reviewable final agency actions. The 2018 aluminum Aquatic Life Ambient Water Quality Criteria provide recommendations for aquatic life. These criteria recommendations are intended to be protective of Aquatic Life Designated Uses, not other uses designated by a state. Aquatic dependent wildlife data, including for birds or	No edits.

Comment Number (Organization)	Public Comment on Topic 9: Regarding the Endangered Species Act	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	of guidelines under section 403 but not to the imposition of any specific effluent limitation on a particular source."[S. REP. 92-414, 92nd Cong. (1 972), reprinted in, 1972 U.S.C.C.A.N. 3668, at 3751]. The House version did not contain a limitation on the scope of the Fish and Wildlife Coordination Act, and ultimately, the Congress adopted a compromise version that did not limit the scope of the Fish and Wildlife Coordination Act.[S. CONF. REP. 92-1236 (1972)]. Clearly, though, Congress intended that EPA would involve the FWS in many aspects of the CWA's implementation. *Coordination under the FWCA should not be burdensome or formalistic. But the reality is that EPA has consistently and systemically failed to fully consider the impacts of its proposals on aquatic wildlife. One of Congress' stated goals in passing the CWA was to achieve "water quality which provides for the protection and propagation of fish, shellfish, and wildlife."[33 U.S.C. §1251(a)(2) (emphasis added)]. Despite this clear statement of a national goal, and despite the repeated inclusion of wildlife as a top priority for protection under the CWA, EPA has consistently failed to fully consider aquatic-dependent wildlife in the development of national criteria.[33 U.S.C. § 1314(a)(1)("The Administrator, after consultation with appropriate Federal and State agencies and other interested persons, shall develop and publish…from time to time thereafter…criteria for water quality accurately reflecting the latest scientific knowledge (A) on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation which may be expected from the presence of pollutants in any body of water, including ground water"); 33 U.S.C. § 1314(a)(2) ("The 'Administrator, after consultation with appropriate Federal and State agencies and other interested persons, shall develop and publish…information…on the factors necessary for the protection and propagation of shellfish, fish, and wildlife…"); 33 U.S.C. § 1314(a)(5)(A) ("the Administrator, to the extent practicable before consideration of any request under section 1311(g) of this title and within six months after December 27, 1977, shall develop and publish information on the factors necessary for the protection of public water supplies, and the protection and propagation of a balanced population of shellfish, fish and wildlife, and to allow recreational activities, in and on the water.").] The Center*	other taxa, are beyond the scope of the data considered in the 2018 Aquatic Life Ambient Water Quality Criteria. The references provided were all included in the final aluminum criteria document with the exception of Naimo (1995).	

Comment Number (Organization)	Public Comment on Topic 9: Regarding the Endangered Species Act	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	recommends that EPA develop water quality criteria that are fully protective of all types of wildlife, including taxonomic groups that EPA routinely overlooks and omits from its analysis. Using the FWCA coordination process as a framework to achieve this would strengthen the final aluminum criteria. ***REFERENCES*** *Elangovan, R., K.N. White and C.R. McCrohan. 1997. Bioaccumulation of aluminum in the freshwater snail Lymnaea stagnalis at neutral pH.* *Huebner, J.D., and K.S. Pynnonen. 1992. Viability of glochidia of two species of Anodonta exposed to low pH and selected metals. Canadian Journal of Zoology 70: 2348–55.* *Kadar, E., J. Salanki, R. Jugdaohsingh, J.J. Powell, C.R. McCrohan, and K.N. White. 2001. Avoidance responses to aluminum in the freshwater bivalve Anodonta cygnea. Aquatic Toxicology 55: 137–148.* *Mackie, G.L. and B.W. Kilgour. 1995. Efficacy and role of alum in removal of zebra mussel veliger larvae from raw water supplies. Water Research 29(2): 731-744.* *Malley, D.E., J.D. Huebner, and K. Donkersloot. 1988. Effects of ionic composition of blood and tissues of Anodonta grandis grandis (Bivalvia) of an addition of aluminum and acid to a lake. Archives of Environmental Contamination and Toxicology 17:479-491.* *Naimo, T.J. 1995. A review of the effects of heavy metals on freshwater mussels. Ecotoxicology 4(6): 341–362.* *Taskinen, J., P. Berg , M. Saarinen-Valta, S. Välilä, E. Mäenpää, K. Myllynen, and J. Pakkala. 2011. Effect of pH, iron and aluminum on survival of early life history stages of the endangered freshwater pearl mussel, Margaritifera margaritifera. Toxicological and Environmental Chemistry 93(9):1764-1777. DOI: 10.1080/02772248.2011.610798.*		

Comment Number (Organization)	Public Comment on Topic 9: Regarding the Endangered Species Act	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*Water quality standards under the Clean Water Act ("CWA") must protect all existing uses in a waterbody, and such "uses" often include supporting species that are listed as threatened or endangered pursuant to the Endangered Species Act.[33 U.S.C. § 1313]. Additionally, under Section 7 of the Endangered Species Act ("ESA"), and its implementing regulations each federal agency, in consultation with the U.S. Fish and Wildlife, must insure that any action authorized, funded, or carried out by the agency is not likely to (1) jeopardize the continued existence of any threatened or endangered species or (2) result in the destruction or adverse modification of the critical habitat of such species.[16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(a)]. "Action" is broadly defined to include actions that may directly or indirectly cause modifications to the land, water, or air, and actions that are intended to conserve listed species or their habitat.[50 C.F.R. § 402.02]. EPA thus must ensure that any criteria that it recommends to states for adoption will be fully protective of listed species.*		

TOPIC 10: Comments regarding exposure routes

Comment Number (Organization)	Public Comment on Topic 10: Regarding exposure routes	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*There are also some contradictions relative to the potential bioavailability of aluminum and whether or not the proposed criteria is conservative. Section 2.6.2 Measures of Effect includes a short discussion that application of the aluminum criteria to total recoverable aluminum may be considered to be conservative as the total recoverable measurement also includes aluminum bound to particulates, implying that such bound aluminum is less bioavailable. However, in section 3.3 Bioaccumulation studies are presented which show that dietary exposures to aluminum bound to particulates is bioavailable to grazing aquatic invertebrates. As water quality criteria are derived to also be protective of these invertebrates, it would seem that the current proposed criteria based on total recoverable aluminum measurements are not conservative, but appropriate for protection of species across the full range of potential exposure pathways. Therefore, the document should not overstate the potential for a conservative application of the criteria though the use of total recoverable aluminum measurements.*	Section 3.3 text discusses that aluminum bound to humic acids may be bioavailable via grazing. In general, humic acids do not equate to particulates as suggested by the comment. Section 3.3 also notes that bioaccumulation and toxicity via the diet are considered unlikely relative to direct waterborne aluminum toxicity (Handy 1993; Poston 1991). This conclusion is also supported by the lack of any biomagnification within freshwater invertebrates that are likely to be prey of fish in acidic, aluminum-rich rivers (Herrmann and Frick 1995; Otto and Svensson 1983; Wren and Stephenson 1991). The opposite phenomena, trophic dilution up the food chain, has been suggested (King et al. 1992).	No edits.

TOPIC 11: Comments regarding other general issues

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0013 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*I have modified Method 1669 that I use during my "Clean Sampling" events. My field blank is set out first, upwind of sample location, and left open to determine environmental impact of airborne metals. In all my sampling events I will scout the river to pick a location that is very representative of river flows, far removed from bridges and road traffic, with sampling taking place beyond riverbank tree canopy. What I have found for ambient contamination is very consistent with Japan's findings and in many instances less. I believe the noted higher levels mentioned in the draft are a result of contamination carried in by the sampling team, or improperly cleaned sampling equipment. I believe the ambient background concentrations of aluminum are overstated and not representative of actual ambient conditions.* *During my sampling projects I worked for the City of Springfield, Massachusetts at both the wastewater and water plants. The main focus was to test the receiving waters for aluminum, copper and lead at low flow conditions. This was done over the summer of 2016 when the receiving waters were near, and in a few instances, below 7Q10 conditions. Background levels were extremely low and patterns were noted during the few times of rain events. The same patterns repeat over and over again regardless of the river being sampled or the watershed location. If the water from the wetlands is stable, absent of rain and groundwater influx, then the humic, fulvic and tannic acids remain in the wetland areas weathering the rocks and organics that are associated with these wetlands while building up aluminum concentrations and lowering the wetland pH. When it rains, the water from the wetlands rises, enters the main waterbodies, drops the pH in these main waterbodies, which in turn begins to drop the alkalinity due to the increased buffering capacity needs, and brings along an increase in both total and dissolved aluminum.* *The West Parish Filters (WPF), Water Treatment Plant had collected over two years (December of 2012 through February of 2015) of chemical concentration data at their two supply reservoirs. The Cobble Mountain Reservoir has 23 billion gallons of storage and the Borden Reservoir has about 2.5 billion gallons of storage. Both reservoirs are in the same watershed, receive the same amount of rainfall as they are approximately located ½ mile from each other and are impacted by the same soils and*	Thank you for your comment. Several sentences have been added to the "Occurrence" section regarding recent common use of "clean sampling techniques" thereby reducing potential for any contamination of samples. We expect new methods for measuring aluminum will be available in the future. Thank you for submitting the interesting data. However, the analysis you submitted cannot be used in the criteria derivation. The EPA reviewed the study by Lydersen et al. (2002) and determined that it was not acceptable for criteria derivation. (Appendix J). The reason the study is deemed unused is that only one aluminum concentration was tested. However, the study did show that both Ca and Na reduced fish mortality (Na reduced mortality more than Ca).	Section 2.1

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	surrounding flora. An aerial view of both reservoirs can be seen at the following link: *https://www.google.com/maps/@42.1362127,-72.9225551,3486m/data=!3m1!1e3?hl=en* *The EPA requested that the WPF collect two-years of chemical concentration data from both reservoirs, along with several other locations within their facility, the upper and lower lagoons and Cook's Brook (the discharge point for the WPF treatment backwash).* *The data from the reservoirs is attached. In my cursory review of the data I noted that the smaller reservoir has total recoverable aluminum (TRA) fairly consistently over 100 ug/l. The larger reservoir consistently had a TRA value of less than 50 ug/l. The dissolved aluminum even demonstrated a wider difference in range between the two reservoirs.* *I had submitted comments on Thursday 9/21/2017 and did not include the attachment on the Oslo Study that I referenced in my comments. The acknowledgement # was 1k1-8ysj-hu1g. Attached for reference with that document is the Oslo Study.* *Abstract: The Effects of Ionic Strength on the Toxicity of Aluminium to Atlantic salmon (Salmo salar) Under Non-steady State Chemical Conditions. Please contact the EPA Docket Center, Public Reading Room to view this document. Address: 1301 Constitution Ave, NW Room 3334 Washington, DC 20004 Telephone: 202-566-1744 Fax: 202-566- 9744 Email: docket-customerservice@epa.gov Prepared by Espen Lydersen et al.* *Authors: Espen Lydersen et al.* *Reason Restricted: This attachment is restricted to show metadata only because it contains copyrighted data.* *Publication Reference: Journal of Limnology 61.1 (2002): 69 - 76*		
EPA-HQ-OW-2017-0260-0013 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*In review of the proposed draft Aluminum Criteria it is evident that much work and review has been done to develop what the current train of thought believes is the best fit models for determination of aluminum toxicity. This dynamic approach is much better than the previous static approach at predicting the toxicity of aluminum to riverine biota.*	Thank you for your comment. The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum.	No edits.

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	From the infancy stages of toxicity studies in the 1980s it was determined that hardness has always played a role in the toxicity of aluminum. There were other factors that were widely studied, but to a very limited degree. Many of these studies are outlined in the greater than 800 references listed on pages 76 through 141 of the draft. *The 'Gold Book' was the standard reference for acute and chronic toxicity. Aluminum has a chronic value of 87 ug/l and an acute value of 750 ug/l within this document. The 'Gold Book' document did indicate that dissolved aluminum was a better predictor of actual toxicity than total aluminum. This belief was held for 30 years until the new release of this document. The current document states, "Toxicity was only observed when the test solutions were unfiltered; furthermore, dose-response was only observed using total aluminum as opposed to measurements of dissolved or monomeric forms (Gensemer et al. 2017). This same effect was observed in 7-day exposures at pH 7 and 8 with the daphnid (Ceriodaphnia dubia) where filtered test solutions were less toxic than unfiltered solutions (Gensemer et al. 2017)….Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured (GEI Consultants, Inc. 2010;"* *This document uses multiple linear regressions (MLR) models and did explore biotic ligand models (BLM) to take data results from varying chemical concentrations during aluminum toxicity analyses (calcium, sodium, magnesium, chlorides, sulfate etc.) and fit the impact of these ionic concentrations into three parameters, pH, hardness and dissolved organic carbon (DOC). It is noted in the section 5.3 that there are data gaps and uncertainties in the development of this draft. There is one specific section that makes a statement of fact, yet indicates the ambiguous nature of this statement because natural waters may contain other species of aluminum that are not biologically available.* *I did develop several questions, but saw that these were brought up in the Peer Review Comments and noted that the EPA had responded too many of the questions.*		

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EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	*WDEQ/WQD appreciates EPA's thorough review of aluminum studies and toxicity data for aquatic organisms. Further, WDEQ/WQD was interested to see how EPA incorporated the effects of other water quality parameters on aluminum toxicity through development of multiple linear regression (MLR) models. Nonetheless, WDEQ/WQD has concerns regarding: the lack of standardization among toxicity studies selected for criteria development; the assumptions and procedural exceptions used during criteria derivation; the limited applicability of MLR models; as well as unclear or missing information in the criteria document.*	Thank you for your comment. Substantive comments on this topic were addressed in other sections of this Response to Comment document. The development of the 2018 final aluminum criteria followed the procedures described in the 1985 Guidelines, with the advancement of more complex consideration of water chemistry impacts on aluminum bioavailability. All studies used in criteria were thoroughly reviewed for data quality. The applicability of the criteria across a broader range of US waters was enhanced by the addition of data and MLR equation incorporate that additional data. Unclear or missing information noted in public comments on the 2017 draft was addressed. The criteria document and all additional data and modeling included after the 2017 draft document were externally peer reviewed. EPA asserts the criteria represent the latest and most scientifically-defensible science.	No edits.
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	*In summary, we request that EPA base the updated aluminum criteria on a wider range of water quality parameters and also consider the use of filtration to remove natural sources that greatly increase the aluminum concentrations especially in wet weather. The potential for aluminum toxicity in surface waters is directly related to the chemical form of aluminum present, which is highly dependent on water quality characteristics of the waterway. We hope that the characteristics typical of many California waterways are represented and considered during development of the final recommended standards.* *[Attachment A: Natural background concentrations during wet weather in southern California creeks]*	Thank you for your comment. Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria were expanded, with details and rationale provided in the criteria document. The EPA is aware, and has noted in the 2018 aluminum criteria document, that under natural conditions not all forms of aluminum would be biologically available to aquatic species (e.g., clay-bound aluminum). The EPA has also noted in its 2018 final aluminum criteria document that the EPA Methods 200.7 and 200.8 are the only currently approved methods for measuring aluminum in natural waters and wastes for NPDES permits. The EPA further notes that research on new analytical methods is ongoing to address concerns with including aluminum bound to particulate matter (i.e., clay) in the total recoverable aluminum concentrations (OSU 2018c). One approach would not acidify the sample to pH less than 2 but rather to pH 4 (pH 4 extracted method) to better capture the bioavailable fraction of aluminum (CIMM 2016, OSU 2018c). The method has recently been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W.	No edits.

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters. The EPA is developing implementation guidance on this topic that will be issued in the future.	
EPA-HQ-OW-2017-0260-0029 *(Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))*	***Summary*** *The draft criteria are a marked improvement over the 1988 aquatic life ambient quality criteria for aluminum in fresh water. However, as with the current criteria, the draft criteria include acknowledged uncertainties that may be resolved using water effect ratio studies and/or by WET testing with common test organisms (D. magna, C. dubia, and P. promelas). The draft criteria should also include a footnote, similar to that provided with the current aluminum criteria, warning that the calculated criteria may be inaccurate for pH, hardness, and DOC concentrations outside the bounds of data used to derive the criteria. The criteria may also be inaccurate where the aluminum present is in the form of clays or other materials that are not bioavailable. This is particularly important for waters with high turbidity or suspended solids as would be expected in stormwater runoff. Finally, the criteria should be adjusted where salmonids are not present.*	Thank you for your comment. The EPA is aware, and has noted in the 2018 aluminum criteria document, that under natural conditions not all forms of aluminum would be biologically available to aquatic species (e.g., clay-bound aluminum). The EPA has also noted in its 2018 final aluminum criteria document that the EPA Methods 200.7 and 200.8 are the only currently approved methods for measuring aluminum in natural waters and wastes for NPDES permits. A new method has recently been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters. The 2018 final aluminum criteria discuss the expanded water chemistry bounds of the criteria, and discuss increased uncertainty outside of the empirical water chemistry bounds for the 2018 MLR model's underlying toxicity tests. The 2018 final aluminum and underlying MLR is reflective of a larger toxicity and water chemistry database than a WER, which can depend greatly on the particular "snapshot" conditions during which the WER tests are conducted.	No edits.

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0035 *(Richard A. Hyde, P.E., Executive Director, Texas Commission on Environmental Quality (TCEQ))*	*Federally-recommended criteria for aluminum were last updated by the EPA in 1988. The 1988 criteria were developed with a limited number of toxicity studies, expressed as a fixed value for waters between 6.5 and 9.0 pH units, and did not account for other site-specific factors.*	Thank you for your comment. The EPA agrees that the 1988 criteria were developed with limited studies and only addressed pH between 6.5 and 9.0.	No edits.
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*Overview of 1988 Criteria Document* *EPA's 1988 document for aluminum begins with a discussion of the geochemistry of aluminum in surface water (EPA 1988). The complexity of its geochemical behavior is attributed to five characteristics: the amphoteric nature of aluminum, its tendency to form complexes with anions, the formation of strong complexes with organic acids, its tendency to form polymers, and its slow chemical equilibration under certain conditions. These characteristics are related to the theoretical solubility of aluminum under different geochemical conditions. From this, it seems that the focus is clearly on dissolved species, which we approximate by using an operational definition of "dissolved" as those components that pass through a 0.45- µm membrane filter.* *Conditions of pH are important specifically because of the greater solubility of aluminum at both lower and higher pH values; again, this relates to the theoretical solubility of aluminum across a range of pH values. The introduction section of the 1988 criteria document appears to acknowledge use of "dissolved" concentrations, stating that, "Hunter et al. (1980) reported that the toxicity of the test solutions was directly related to the concentration of aluminum that passed through a 0.45 µm membrane filter." This quote, along with the first three pages of the 1988 document, leads the reader to believe the criteria will be based on dissolved aluminum (i.e., data from field-filtered samples); however, the last paragraph of the introduction section appears to contradict this. The third sentence of the last paragraph states, "Unless otherwise noted, all concentrations of aluminum in water reported herein from toxicity and bioconcentration tests are expected to be essentially equivalent to acid-soluble aluminum concentrations." The question becomes, how does the term, "acid-soluble" relate to the standard definitions of "dissolved" or "total" (i.e., field-filtered or not)?*	Thank you for your comments. The discussion of the 1988 AWQC document in the 2018 final criteria document was reviewed for clarity and edited where appropriate. The EPA is developing implementation guidance on this topic that will be issued in the future.	Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	The "Implementation" section (pages 10-15) of the 1988 document attempts to clarify the "filtered/unfiltered" question, stating that, "Previous aquatic life criteria for metals and metalloids (U.S. EPA 1980) were expressed in terms of the total recoverable measurement (U.S. EPA 1983a), but newer criteria for metals and metalloids have been expressed in terms of the acid-soluble measurement." The text goes on to explain that, "acid-soluble measurement does not require filtration of the sample at the time of collection, as does the dissolved measurement. The only treatment required at the time of collection is preservation by acidification to a pH between 1.5 and 2.0, similar to that required for the total recoverable measurement." This quote indicates use of data from samples that are not filtered prior to acidifying the sample for preservation. By this description, "acid soluble" is equivalent to what most practitioners would call "total" (i.e., unfiltered). *The discussion of "acid-soluble" versus "dissolved" versus "total" versus "total recoverable" and the timing of filtering and size of filter (0.1-µm versus 0.45-µm) continues at length in pages 12 through 15 of the 1988 document. In this discussion, it seems that the acidified sample is then filtered; however, this is a misrepresentation of the load of dissolved metals in the neutral-pH stream. For example, page 13 of the 1988 document states:* *"The intent of the acid-soluble measurement is to measure the concentrations of metals and metalloids that are in true solution in a sample that has been appropriately acidified. Therefore, material that does not pass through a filter with smaller holes, such as a 0.1 um membrane filter should not be considered acid-soluble even if it passes through a 0.45 um membrane filter. Optional filtration of appropriately acidified water samples through 0.1 um membrane filters should be considered whenever the concentration of aluminum that passes through a 0.45-um membrane filter in an acidified water sample exceeds a limit specified in terms of acid-soluble aluminum."* *Based on all the above, it is no wonder that the 2017 criterion document seems confused as to whether concentrations of dissolved (i.e., field-filtered) or total (i.e., not field-filtered) aluminum were used as the basis of the criteria in the 1988 document for aluminum.*		

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EPA-HQ-OW-2017-0260-0043 *(Blake Beyea, Standards Unit Manager, Water Quality Control Division, Colorado Department of Public Health & Environment)*	*The Colorado Water Quality Control Division (division) appreciates the opportunity to provide comments on the 2017 Draft Aquatic Life Ambient Water Quality Criteria for Aluminum. The division also appreciates EPA's substantial effort to develop these draft criteria, as their scientific basis is a significant improvement over the existing criteria.* *The division is responsible for the daily implementation of the Clean Water Act's water quality programs, including the water quality standards programs for which states are responsible under the Clean Water Act. Therefore, the proposed criteria and their ability to be implemented are of interest to the division.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0052 *(Heidi L. Dunn, President, Freshwater Mollusk Conservation Society (FMCS))*	*Please accept these comments submitted on behalf of the Freshwater Mollusk Conservation Society on the Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater (https://www.gpo.gov/fdsys/pkg/FR-2017-09-26/pdf/2017-20597.pdf).* *We are writing to advocate on behalf of a freshwater standard for aluminum that is protective of larval and juvenile forms of freshwater mollusks and of threatened and endangered species in particular. Freshwater mollusks are the most imperiled group of organisms in United States with nearly two-thirds of species being identified as at risk-of extinction. It is thus of utmost importance for the Environmental Protection Agency to develop water quality criteria that are protective of these sensitive organisms.*	Thank you for your comments. Studies with freshwater mussels were conducted by USGS (*Lampsilis siliquoidea* acute and chronic tests reported by Wang et al. 2018) and are included in the 2018 aluminum criteria derivation. Additional responses to mussel comments are included in Topic 15 in this Response to Comments document.	No edits.
EPA-HQ-OW-2017-0260-0054 *(Anonymous public comment)*	*According to this Proposal:* *"EPA is updating the aluminum criteria to better reflect the latest science. Unfortunately, there are not enough data to support the development of estuarine/marine criteria at this time. "* *This critical statement should provoke the recognition of the reality that the common-sense, responsible action here should be to concentrate on more research and data before altering criteria, when obviously the essential data does not exist to address the many serious questions that are well known to the public and health professionals and researchers.* *The action necessary is research, not formulaic conjecture.* *"Unlike the fixed acute and chronic values found in the 1988 document, this draft document provides users the flexibility to*	Thank you for your comments. Current science demonstrates that the toxicity of aluminum to aquatic organisms is dependent on the water chemistry conditions, thus the criteria were derived to be sensitive to these key water quality parameters. The EPA did not derive criteria for estuarine/marine waters due to a lack of data, consistent with the comment. The AWQC document has undergone independent, external expert peer review and represents the best available science. The averaging durations for the aluminum criteria are based on long-standing EPA methodological guidance (1985 Guidelines).	No edits.

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	develop site-specific criteria based on a site's water chemistry." *The public does not want flexibility when it comes to the health and safety of the American people.* *"The resulting acute criterion would have an appropriate level of protection if the one-hour average concentration is not exceeded more than once every three years on average. If the four-day average concentration is not exceeded more than once every three years on average, the chronic criterion is protective.* *The flexibility here to have the determination depend on "average" is not reassuring, because this is a presence that once it's there, it's there, and entering into the biological chain in any concentration, no matter the interval of occurrence is not acceptable.* *Further, if one is the recipient of an above-average exposure, that binds with biological functioning, then average is of little consolation or rationality.* *In the absence of data, or further research on the questions that deeply concern Americans, it is particularly disturbing that the proposed values in criteria are double the existing standards.* *It is stated:* *Note: Values will be different under differing water chemistry conditions as identified in this document.* *!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!* *This is precisely the reality! Freshwaters are characterized by a network of tributaries and variable flows. This averaging can be totally misleading as a discharge into a tributary may have major impact in its concentration with serious consequences in exposure along a short segment, but then not register very much on the average!* *"Once final, the criteria will serve as recommendations to states and tribes by defining the concentration of aluminum in water that will protect against harmful effects to aquatic life."* *To alter criteria in the absence of the necessary data and to impose a more lenient framework based on "averages" and present it as*		

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	an official recommendation when so much is unknown is irresponsible. *What we have now is not "final" criteria of any kind.* *The EPA is entrusted with the awesome responsibility of protecting the public from environmental hazards.* *To posit this conjecture and knowingly send it out as guidance in the absence of data and research in range and depth that would provide assurance of safety is irresponsible.* *The American people, if they were fully aware of this, would not be happy.*		
EPA-HQ-OW-2017-0260-0059 *(Jeff Henderson, President, Aluminum Extruders Council)*	*The Aluminum Extruders Council represents over 100 extruders and suppliers across the United States. After reviewing all available information on this issue, we stand in support of the recommendations of the Aluminum Association. We encourage the EPA to take those comments under careful consideration as you deliberate this issue.*	Thank you for your comment. The specific comments of the Aluminum Association were addressed in this Response to Comment document.	Edits were made based on the Aluminum Association comments, as appropriate.
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*The US EPA Database* *US EPA has spent years developing the Draft Aluminum Criteria. It is impossible, within the brief time allowed, to adequately assess each of US EPA's data decisions for inclusion and exclusion of specific studies. Some of the cited materials have only been available to the public for a limited time, and they are integral to the Draft Aluminum Criteria.* *Based on a brief comparison, US EPA has included some studies that West Virginia determined were inappropriate for inclusion, and vice versa. These small decisions affect the genus mean acute or chronic values (GMAVs and GMCVs) and therefore are significant. The following table compares the GMAVs and the resultant CMC (acute criterion) for the four most sensitive species in the West Virginia database as compared to the US EPA database:* *[Table 3]* *While the CMCs appear comparable, the West Virginia database was normalized to a hardness of 50 mg/l, whereas the US EPA database was normalized to a hardness of 100 mg/l. Considering*	Thank you for your comments. The AWQC document has undergone independent, external expert peer review and represents the best available science. The commenter is incorrect in stating that the EPA's database was normalized to a hardness of 100 mg/L. The EPA's database was normalized based on peer-reviewed multiple linear regressions (DeForest et al. 2018a, b) accounting for the variable effects of aluminum across a broad range of total hardness, dissolved organic carbon and pH conditions. This approach of including these three water chemistry parameters in calculating appropriately protective criteria represents the best available science as indicated in peer-reviewed publications (e.g., Brix et al. 2017, ET&C). In not considering all three critical water chemistry parameters relevant for water chemistry, West Virginia may have come to conclusions that are different than the EPA's. In fact, peer-reviewed publications demonstrate that pH and DOC have a larger overall impact on bioavailability and toxicity of aluminum than the hardness parameter that is the focus of the West Virginia analysis. EPA has shared these data and analyses with West Virginia and discussed available	No edits.

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	the mitigating effect of hardness, the two numbers are no longer in the same ballpark. *Likewise, the data decisions affect the ranking of each species. The D. magna number is significantly higher in the West Virginia database (which was normalized for hardness) as compared to the US EPA database (which was normalized using the MLR for hardness, pH, and DOC for only two species). The normalization process dramatically shifts the balance between certain species for toxicity. Ceriodaphnia were the most sensitive genus in the West Virginia database. In the US EPA database, Ceriodaphnia were not among the four most sensitive genera.* *West Virginia and US EPA took a dramatically different approach with the chronic criterion (CCC). The West Virginia number was based upon the final acute to chronic ratio, whereas US EPA constructed a chronic database and calculated the FCV from the GMCVs. Therefore, the comparison is not as simple. However, the FCVs can be directly compared:* *[Table 4]* *The US EPA FCV is calculated at a much higher hardness, yet the value is much lower. We believe this difference is due at least in part to the inclusion of a recently published mussel study. However, a more substantial part of the issue may be with the use of the MLR, as the range of hardness and DOC are very limited in the EPA database.* *Even with the thirty-day extension, US EPA has not allowed adequate time to evaluate each of its data decisions. This is a lengthy exercise. In communications with WVDEP, US EPA claims to have been working on the aluminum criteria for roughly four years. However, US EPA expects the public to assess its work and to provide meaningful, thorough comments in ninety days.* *Our comments are focused on the overall issues with the criteria development, along with the four most sensitive species identified in the chronic database. According to the 1985 Guidelines, only the four GMCVs which have cumulative probabilities closest to 0.05 are selected for calculation of the FCV. When less than 59 GMCVs are available, these will always be the lowest four GMCVs*	information on toxicity to mussels. The criteria are not presented nor intended to represent conditions only at a hardness of 100 mg/L. Tables presented in the criteria document show that the criteria values change with changing water chemistry and can be calculated for any water chemistry conditions within the bounds of the model as specified in the criteria document. Since the 2017 draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. The total hardness of toxicity test waters ranged from 9.8 to 428 mg/L. The DOC of toxicity test waters ranged from 0.08 to 12.3 mg/L. The pH of toxicity test waters ranged from 6.0-8.7. Please see the 2018 final aluminum criteria document for a detailed discussion in Section 2.7.1. The criteria calculations in the 2018 criteria document and associated calculator were completed per the 1985 Guidelines procedures.	

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	(1985 Guidelines, p. 31). The inclusion or exclusion of other studies will only affect N, a factor used in the FCV calculation. While we anticipate that the problems are more extensive, the narrow focus allows for the preparation of timely comments that demonstrate the issues with the Draft Aluminum Criteria.		
EPA-HQ-OW-2017-0260-0070 *(Jeff Henderson, President, Aluminum Anodizers Council)*	*The Aluminum Anodizers Council represents over 100 anodizers and suppliers across the United States. After reviewing all available information on this issue, we stand in support of the recommendations of the Aluminum Association. We encourage the EPA to take those comments under careful consideration as you deliberate this issue.*	Thank you for your comment.	No edits.
EPA-HQ-OW-2017-0260-0074 *(Timothy F. Moore, Risk Sciences, on behalf of Lake Elsinore and Canyon Lake Nutrient TMDL Task Force administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA))*	*EPA also cites several other field studies where relatively high aluminum concentrations were associated with reduced richness and abundance of fish and invertebrate species. [Draft Criteria @ pg. 63-64] However, all of these studies were conducted in lakes and streams with low pH (<5 s.u.) and very low hardness. Such conditions are not typical of western waters.*	Thank you for your comment. The field studies discussed was not used in the database for the quantitative criteria calculation approach.	No edits.
EPA-HQ-OW-2017-0260-0075 *(Steven A. Buffone, CHHM, QEP, GIT, Supervisor, Compliance and Regulatory Affairs, CONSOL Energy Inc.)*	*We recommend that EPA review additional data and studies available through states, such as West Virginia, and continue to refine the Criteria so that expanded ranges for both hardness and DOC are addressed.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. The total hardness of toxicity test waters ranged from 9.8 to 428 mg/L. The DOC of toxicity test waters ranged from 0.08 to 12.3 mg/L. The pH of toxicity test waters ranged from 6.0-8.7. The Multiple Linear Regression equations were updated based on this new data. As a result, the recommended bounds of the criteria have expanded. The 2018 aluminum criteria document provides an extensive discussion of the new, expanded bounds of the criteria and model in Section 2.7.1.	No edits.

Comment Number (Organization)	Public Comment on Topic 11: Regarding other general issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0067 *(Patrick McDonnell, Secretary, Pennsylvania Department of Environmental Protection (DEP))*	***3. Hardness vs. calcium content*** *Hardness has long been monitored by water companies due to its tendency to cause mineral deposits in pipes and leave soap scum on bathtubs. The correlation between hardness and ameliorative effects on pollutants has long been known, and since this discovery some work has been done to try to understand what elemental components of hardness are protective and the mechanism behind such protection. For example, research by Davies and Hall has indicated that calcium may be the component in hardness most responsible for biological protection against some common toxins. [Trevor D. Davies and Ken J. Hall, "Importance of Calcium in Modifying the Acute Toxicity of Sodium Sulphate to Hyalella Azteca and Daphnia Magna," Environmental Toxicology and Chemistry 26, no. 6 (2007): 1243-1247.] Knowing what components of hardness are protective and establishing standards based upon them could ultimately lead to better criteria for aquatic life protection.* *EPA should consider the possible use of calcium and/or magnesium concentrations to see if they correlate with biological protection better (or worse) than the more general "hardness" parameter.*	The EPA is aware of studies indicating the importance of calcium in the effect of hardness on toxicity of chemicals to aquatic organisms. However, the vast majority of aluminum toxicity studies available provided only reported total hardness and not individual Ca and/or Mg concentrations. The EPA thus based the 2018 final aluminum criteria on total hardness, a parameter frequently measured by implementing entities, which also increases the utility of its application.	No edits.

TOPIC 12: Comments providing information on external research

Comment Number (Organization)	Public Comment on Topic 12: Providing information on external research	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0013 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*I reviewed the pH and alkalinity and noted that both were lower in the Borden Reservoir where the TRA and ASA were higher. This is what would be expected. Upon closer inspection I also noted the calcium was quite lower in the Borden Reservoir. This followed the study done by ENSR in Region 8 in regards to Brook Trout. The findings indicated that fish would use the ionic charge from the calcium to trap aluminum around the outside of their gills and prevent the aluminum from entering the fish's body thus allowing much higher levels of aluminum before toxic effects were demonstrated.* *I had also subsequently read a study by the University of Oslo (attached) titled The effects of ionic strength on the toxicity of aluminum to Atlantic salmon (Salmo salar) under non-steady state chemical conditions which was authored by, Espen LYDERSEN, Sigurd ØXNEVAD1), Kjartan ØSTBYE1), Ronny A. ANDERSEN1), Frode BJERKELY1), Leif Asbjørn VØLLESTAD1) and Antonio B.S. POLÉO1)* The study indicated sodium was a better protector of fish from the effects of aluminum than calcium. In reviewing that report and comparing the findings to the data gathered by WPF it was clear that these two reservoirs were an actual in-vitro process of the pilot study that was outlined in this paper. The reservoirs chemistry was identical to the findings within the pilot study.* *I contacted the WPF Forester and questioned her at length about the status of the fish at both reservoirs. Her conclusion was the fish and amphibian life in both reservoirs was vibrant and identical as she could tell. Bald eagles and Osprey fished often in both reservoirs and no fish kills had ever been noted during her tenure.* *For the purpose of comments on this draft I put together a spreadsheet with graphs of all the data that is implicated in this draft and the Oslo Study (pH, alkalinity, DOC, sodium and calcium). Note the TRA on the Cobble Reservoir that has a spike on the 4th sample (99 ug/l – yellow box) the 14th sample (69 ug/l – green box), the 17th sample (64 ug/l – also green box), the 23rd sample (100 ug/l – blue box) and the 26th sample (51 ug/l – pink box).* *I then plotted the DOC, alkalinity and pH. Those graphs are below*	Thank you for submitting this important research. However, the analysis you submitted cannot be used in the criteria derivation. We agree that additional research on aluminum could focus on other parameters and cations (such as sodium and calcium). However, at this time we focused the models on the best available data at this time.	No edits.

Comment Number (Organization)	Public Comment on Topic 12: Providing information on external research	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	the TRA graphs and I add the associated correlating colored boxes. *[Graphs x 4]*		
EPA-HQ-OW-2017-0260-0013 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*Only one Box correlated with increasing TRA and decreasing DOC (yellow colored box), while both the green and blue boxes demonstrated increased DOC with increased TRA. If the MLR model is to hold true DOC would have to decrease with each increase of TRA. This did not happen in the Cobble Reservoir.* *The yellow box and pink box in the alkalinity graph decreased with increasing TRA and one of the two data points in the green box decreased with increasing TRA. This is a better predictor than the DOC, but still did not happen in every case and therefore it would not satisfy the requirements of a true trending model.* *As the pH trends were close it was a bit tougher to follow the trends. It does seem like in three instances the pH did slightly drop when there was an increase in TRA.*		
EPA-HQ-OW-2017-0260-0013 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*I took the same TRA graph and matched it against sodium and calcium (below).* *[Graphs x 3]* *In the four cases where the Cobble Reservoir TRA trended upward significantly, the sodium and calcium for that month trended downward. This was identical to the findings of the Oslo Study, and would be a much better predictor in a MLR model with apparently more consistency over the use of DOC and Alkalinity.* *The DOC in the Borden Reservoir (consistently higher pH) has an abundance of DOC when compared to the Cobble Reservoir. If DOC is used more for high aluminum waters this does not bear out in the data from both reservoirs. The draft proposal does touch upon DOC, but it doesn't indicate whether or not it should be higher or lower in high TRA/ASA waters.* *I believe future research should focus on the sodium and calcium aspects of parameters that are relevant to the toxicity of aluminum. Also, with such an environment rich example of two reservoirs in western Massachusetts, with identical flora and fauna, and having such a vastly different aluminum content, this may be a ripe are for*		

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	further study. *WPF has these area protected by fencing, the fish are very mature as no fishing is allowed in either reservoir and conditions are ideal for a long-term study of the impacts of aluminum when considering a whole host of impacts. The baseline can be easily established and an in-vitro real-time study could be completed. U-Mass Amherst and University of Oslo exchange students could pick up where the authors of the Oslo Study left off and really get some meaningful research with little to no doubt regarding data gaps.*		
EPA-HQ-OW-2017-0260-0026 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*I had submitted comments on Thursday 9/21/2017 and did not include the attachment on the Oslo Study that I referenced in my comments. The acknowledgement # was 1k1-8ysj-hu1g. Attached for reference with that document is the Oslo Study.* ***Abstract**: The Effects of Ionic Strength on the Toxicity of Aluminium to Atlantic salmon (Salmo salar) Under Non-steady State Chemical Conditions. Please contact the EPA Docket Center, Public Reading Room to view this document. Address: 1301 Constitution Ave, NW Room 3334 Washington, DC 20004 Telephone: 202-566-1744 Fax: 202-566- 9744 Email: docket-customerservice@epa.gov Prepared by Espen Lydersen et al.* ***Authors**: Espen Lydersen et al.* ***Reason Restricted**: This attachment is restricted to show metadata only because it contains copyrighted data.* ***Publication Reference**: Journal of Limnology 61.1 (2002): 69 – 76*	Thank you for submitting this study. The EPA reviewed the study and determined that it was not acceptable for criteria derivation. (Appendix J). The reason the study is deemed unused is that only one aluminum concentration was tested. However, the study did show that both Ca and Na reduced fish mortality (Na reduced mortality more than Ca).	No edits.

TOPIC 13: Comments regarding the lack of marine criteria

Comment Number (Organization)	Public Comment on Topic 13: Regarding the lack of marine criteria	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*Another issue of concern for coastal states is the uncertainty regarding the potential for aluminum to affect marine aquatic communities. As presented in the current draft aluminum criteria document there is insufficient data to develop marine water quality criteria for aluminum. However, the data included in the current criteria development document shows that aluminum toxicity to the most sensitive marine organism studied is measured at aluminum concentrations one to two orders of magnitude below the concentrations that are acutely toxic to the most sensitive freshwater organisms evaluated. EPA should work to close this data gap quickly. The potential to adjust aluminum water quality criteria within freshwater portions of rivers and streams that then flow into marine waters could potentially put those downstream waters into jeopardy if aluminum is more toxic to marine aquatic organisms.*	EPA was able to obtain some data from Australia on estuarine/marine toxicity tests for aluminum, and that is captured in the criteria document, however we still do not have sufficient data to develop estuarine/marine criteria. EPA agrees that this remains a data gap.	No edits.
EPA-HQ-OW-2017-0260-0055 *(Anonymous public comment)*	*I do not think the EPA should update the aquatic criteria for "site specific" due to recent technological advances. The criteria for aquatic life should be updated entirely for the safety of sea life. Many fish are being affected by pollution even though they are within the water. EPA please protect our sea life not for site specific but for the entirety.*	Thank you for your comment. Current science indicates that a location's water chemistry greatly affects aluminum bioavailability and toxicity. Thus EPA's 2018 final aluminum criteria reflects this information. EPA was able to obtain some data from Australia on estuarine/marine toxicity tests for aluminum, and that is captured in the criteria document, however we still do not have sufficient data to develop estuarine/marine criteria. EPA agrees that this remains a data gap.	No edits.

TOPIC 14: Comments regarding the MLR (multiple linear regression) models

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*There is no temperature element to the MLR model despite significant literature that suggest temperature modulates aluminum toxicity. For instance, Stubblefield et al. (2012) studied several different aquatic species at pH 6. They found that pH, dissolved organic matter, and temperature had the largest influence on aluminum toxicity with calcium, sodium and fluoride having only having a minor influence. Other studies have found similar relationships between aluminum toxicity and temperature for brown trout and Atlantic salmon. The impacts of water temperature are noted in the literature review section of the document, but no justification was provided as to why this parameter was not a part of the model.* ***The model should include temperature, or at the very least acknowledge the influence temperature plays in the bioavailability of aluminum to aquatic organisms, and explain why it was not incorporated into the guidance****.*	We are unable to locate the reference cited; the citation is not provided in your comments. Temperature was not considered because of the lack of experimental data that could be used to develop an additional parameter in the MLR.	No edits.
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	*The MLR models developed by DeForest et al., which EPA uses to normalize aluminum criteria were developed with chronic toxicity data from two animals species, one invertebrate (C. dubia; a sensitive species) and one fish (fathead minnow; a moderately sensitive species). If EPA recognizes the uncertainties and limitations of the model, EPA should consider additional studies that minimize the uncertainties and thus bolster the models' protectiveness across a more diverse range of species before moving forward with issuing final criteria.*	Thank you for your comment. We consider the fathead minnow to be representative of other vertebrates, and that the cladoceran is representative for other invertebrates. In particular, the mechanisms of aluminum toxicity to fish based on bioavailability of aluminum are expected to be similar across freshwater species due to similarity in gill microenvironment among fathead minnows and other species (e.g., salmonids). It is well known that the solubility of aluminum decreases as pH is elevated in acidic water (ambient surface or gill microenvironment). Aluminum toxicity subsequently increases because aluminum polymerizes and accumulates on the gill surface. Thus, because of the similarity in the gill microenvironment among freshwater fishes in soft water, it is not expected that aluminum toxicity would be expressed differently in salmonids, for example, as compared to the fathead minnow. The EPA also used the invertebrate *Ceriodaphnia dubia* as a surrogate for other invertebrates. The use of surrogate species to predict effects in other organisms is a standard practice in ecological risk assessment because toxicity data are typically limited. *C. dubia* and *P. promelas* were used as surrogates to test the effects of water chemistry on aluminum bioavailability and toxicity, not for the purposes of establishing the relative sensitivity of genera, which is	No edits.
EPA-HQ-OW-2017-0260-0029 *(Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))*	*The database and the procedures used to normalize the data for criteria development are also subject to uncertainty as discussed in the Draft.* *There are additional uncertainties, beyond those described above, associated with the normalization of aluminum toxicity data using the MLR models developed by DeForest et al. (2017). The models were developed with chronic toxicity data from two animal species, one invertebrate (C. dubia; a sensitive species) and one fish (fathead minnow; a moderately sensitive species). Incorporating additional species in the model development would improve the representativeness of all species, and further validate the MLR model use across species. Though the pH, hardness, and DOC do explain the majority of differences seen in the toxicity data between the two species, there are two MLR models developed (invertebrate C. dubia model and vertebrate P. promelas model), which better*		

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	delineate the differences in their uptake of aluminum. Because the arthropod phylum is highly diverse, there is uncertainty in the application of the C. dubia model across other invertebrate taxa. (Draft at 71) *The MLR models are used to normalize the toxicity test result data to specific conditions of pH, hardness and DOC for evaluating the CMC and CCC. As noted above, these regressions were developed for a single invertebrate (C. dubia) and a fish (fathead minnow), with the MLR models applied to all invertebrates and vertebrates, respectively. Given the diversity of the invertebrates, this approach lends itself to a high degree of uncertainty. Moreover, in developing the MLR model for C. dubia, the Draft notes that a negative* pH^2 *term was added to account for the fact that aluminum bioavailability decreases from pH 6 – 7 and then increases from pH 7 – 8. (Draft at 29).*	captured in the sensitivity distribution for the criteria. In the 2018 final aluminum criteria, the EPA used separate MLRs for fish and invertebrates to best capture the effects of water chemistry on toxicity for the taxa and differences in trends across water chemistry; Section 2.7.1 discusses the pH, hardness and DOC normalization approach the EPA took in the 2018 aluminum criteria document. Appendix L of the 2018 criteria document discusses the comparison of the MLR models used to normalize the toxicity data and compares the results of the fish and invertebrate and pooled taxa MLR approaches in detail. In addition, the ranges of pH for the toxicity tests was broadened above pH of 8. The EPA used the best available science to generate a scientifically sound updated 2018 aluminum criteria document and described uncertainties in the criteria document.	
EPA-HQ-OW-2017-0260-0029 (Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))	*A review of the text justifying this relationship (aluminum toxicity lowest at normal pH (approximately 7.0) with toxicity increasing as the pH increases or decreases from normal) only identifies studies using rainbow trout. (Draft at 11) Consequently, it is not apparent that the MLR model presented for C. dubia is appropriate, as it would seem more relevant for salmonids. The graphic illustrating the chronic toxicity data for C. dubia and the MLR model fit to these data (Figure 4, Draft at 30) does not clearly show increasing toxicity as pH varies above and below 7.5. This is due to the fact that toxicity was not evaluated at a pH of 7.5 (which would show if toxicity is further reduced at this point) and no measurements were made at pH > 8.1 to verify that aluminum toxicity continues to increase at higher pH for this organism. Whole effluent toxicity tests using aluminum sensitive organisms (D. magna for acute tests and C. daphnia for chronic tests) are warranted to resolve this uncertainty.*		
EPA-HQ-OW-2017-0260-0030 (Nelson Brooke, Riverkeeper et al., Black Warrior Riverkeeper)	*Finally, we agree with, and would like to reiterate certain comments submitted by David Waterstreet on behalf of the Wyoming Department of Environmental Quality, who notes:* *The invertebrate and vertebrate MLR models were derived based solely on chronic toxicity data for the cladoceran, Ceriodaphnia dubia, and the fathead minnow, Pimephales promelas, respectively.* *After reviewing the MLRs, WDEQ/WQD's initial concern is the*		

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	applicability of such species-specific models to broader invertebrate and vertebrate taxonomic groups. Further, neither C. dubia nor P. promelas are among the most sensitive taxa used to derive criteria values at a normalized pH of 7, hardness of 100 mg/L and DOC of 1 mg/L. EPA does not present any information on how the MLRs would be representative of other species and/or genera and acknowledges that including other species would improve model representativeness, notably for the invertebrate MLR due to arthropod diversity. Therefore, prior to finalizing the models and criteria, WDEQ/WQD recommends that EPA explore how other taxa may respond to varying levels of pH, hardness and DOC. Without such an analysis, there remains fundamental uncertainty regarding the applicability of the recommended criteria to other taxa. *While we understand that C. dubia and P. promelas are common indicator species used for determining toxicity, we agree that the criteria should be evaluated for toxicity across a much broader, more representative range of taxa.*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The EPA should perform additional studies necessary to expand the range of hardness and DOC used to derive the MLR model in order to encompass the higher natural hardness concentrations (>300 mg/L) commonly observed in the arid southwest and the higher natural DOC concentrations commonly observed in stormwater runoff (> 10 mg/L). Pending completion of such studies, the Tables in Appendix K should be revised to delete the recommended values for hardness concentrations greater than 150 mg/L because these "bounded estimates" are speculative and not supported by any actual evidence in the given range.*		
EPA-HQ-OW-2017-0260-0051 *(Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))*	*MassDEP has conducted independent laboratory studies in cooperation with USGS to investigate the influence of natural dissolved organic matter on aluminum toxicity for low hardness waters using an aluminum-sensitive test species.* *The USGS investigated the influence of dissolved organic matter on aluminum toxicity to the species, Ceriodaphnia dubia, by conducting a series of 7-day/3-brood chronic tests, with endpoints of survival and reproduction. Test waters consisted of serial dilutions of two low hardness natural waters collected from sites in Massachusetts (Beaver Brook at South Royalston, USGS 01163900; and Unnamed Tributary 2, Whitehall Res, NR, Woodville, USGS 010974573), which had DOC concentrations of*	Thank you for your comment. Since we do not have access to the data, the results cannot be considered at this time.	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	6 and 10 mg/L, well above the 5 mg/L DOC maximum in the MLR model. Tests were conducted at hardness levels of 20 and 35 mg/L, with hardness-adjusted site waters mixed with hardness-adjusted, low-DOC lab water (diluted well water; DOC <0.4 mg/L) to produce test waters containing 100 percent, 50 percent, and 25 percent of the original DOC concentration. Toxicity tests were conducted in an incubator with a controlled CO_2 *atmosphere to maintain pH close to the target range of 5.8-6.2. Results of these tests are being used to estimate chronic effect concentrations for C. dubia (e.g., EC50 for 50 percent reduction in reproduction), expressed as total (unfiltered) aluminum concentrations. Results from the tests are being finalized. Publication of the results is expected in March 2018. MassDEP requests that these data be considered by EPA and that the MLR model be adjusted to extend the upper range of DOC.*		
EPA-HQ-OW-2017-0260-0058 (National Council for Air and Stream Improvement, Inc. (NCASI))	*It is helpful that a peer review panel has provided EPA with input on the modeling approaches that EPA has considered, including the MLR model. However, the Deforest et al. (2017) article has only been recently made available in an early published, electronic form. As a result, there is considerable additional scientific information that may be generated that could support or refine the information contained in this article, or could lead to substantial changes in model parameters and use. In addition, EPA has decided to select the MLR statistical modeling approach over a more mechanistic biotic ligand model (BLM) approach. The basis for EPA's decision should be clearly described. We note that a BLM approach is used in EPA's revised copper aquatic life water quality criteria (EPA 2007, EPA 2016). One advantage of mechanistic models is that they can better capture causal mechanisms and may therefore better predict toxicity in previously unmeasured conditions when adequate data are available (EPA 2009). However, we acknowledge that the MLR approach may represent an adequately predictive method for many situations that is simpler to implement (e.g., fewer model inputs, and therefore potentially easier to provide appropriate values for all input parameters), while still providing practical improvements over the existing criteria. We also note that an aluminum BLM may still be used as an optional alternative, scientifically valid approach. EPA should continue to assess the science and relative merits of the MLR and BLM approaches for aluminum to ensure that important differences are considered in future revisions of aluminum water quality criteria.*	Please reference Section 5.3.5 for the rationale for why the EPA chose to pursue the MLR models published by DeForest et al. (2018a, b) over the BLM approach (Santore et al. 2018).	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0066 *(David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)*	*EPA should compare the MLR approach to other methods such as the Biotic Ligand Model to confirm the reliability of the input variables MLR results.*	The EPA asked external expert peer reviewers to investigate the performance of the Aluminum BLM compared to MLR models that incorporated only pH and total hardness. Please refer to the 2018 aluminum criteria web page (https://www.epa.gov/wqc/aquatic-life-criteria-aluminum#2018) or EPA docket for this information. Please also reference Section 5.3.5 for the rationale for why the EPA chose to pursue the MLR models published by DeForest et al. (2018a, b) over the BLM approach (Santore et al. 2018).	No edits.
EPA-HQ-OW-2017-0260-0071 *(Fredric P. Andes, Coordinator, Federal Water Quality Coalition (FWQC))*	*While we generally support use of the MLR models, it is important to recognize that there are some uncertainties involved (particularly in derivation of acute criteria). Also, because the method focuses on a few specific variables, it may not be as fully reflective of the water quality variables that drive aluminum toxicity as other approaches that utilize more variables. Therefore, we believe that EPA should consider developing a comparison of the MLR approach and other methods, such as the Biotic Ligand Model, to help confirm the reliability of the MLR results.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Given that significant acute toxicity data exist under a range of water quality conditions, is it possible for EPA to provide an analysis of the applicability of the chronic MLR, perhaps even using the BLM as an independent means of checking the accuracy of acute normalization outcomes using the chronic MLR? Given that a number of studies used to calculate the ACR were unbounded, we recognize that there is some uncertainty with the ACR presented in the draft criteria document. We recommend that EPA review whether any additional studies would be acceptable for refinement of the ACR. Additionally, it would be beneficial if EPA could provide a discussion on whether a "reverse" application of an ACR would be acceptable approach for deriving acute criteria as an alternative to the application of the chronic MLR to normalize acute data. Another option might be to use this reverse application of the ACR as a bounding calculation to confirm the accuracy of acute criteria calculations derived using application of the chronic MLR to acute data.* *[Cited References]*	The 2018 final criteria document notes, in Section 5.3.5, that both the MLR (DeForest et al. 2018a, b) models and the BLM model (Santore et al. 2018) include the mostly the same toxicity test data, with the BLM including additional data on the accumulation of aluminum on the gills of Atlantic salmon (Santore et al 2018). The MLR approach empirically curve-fits log-log pH, total hardness and DOC relationships (with interaction terms) to the empirical data. The BLM uses a mechanistic model based on an underlying theory of how water chemistry input parameters affect aluminum toxicity, although it still has empirically derived factors. EPA agrees that the use of the chronic MLR to normalize acute toxicity data is an area of uncertainty. It is discussed in the document in the Effects Characterization Section 5, specifically in Subsection 5.3. Chronic data were used in the MLR model used to reflect the effects of pH, DOC and hardness on aluminum bioavailability and toxicity to normalize the sensitivity distribution data. Application to acute toxicity data assumes that the same relationship with aluminum bioavailability and aquatic toxicity are present under shorter, acute exposures, which is postulated to be an appropriate assumption to make given available data. This uncertainty associated with the	No edits.

Comment Number (Organization)	**Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models**	**EPA Response**	**Revision Location in 2018 Aluminum Criteria Document**
		model is a future research area that could be further investigated.	
EPA-HQ-OW-2017-0260-0014 (David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))	*WDEQ/WQD has other concerns regarding MLR model development. Both the invertebrate and vertebrate models were developed using chronic toxicity data. To account for acute toxicity in the models, EPA assumes that the effect of water chemistry on aluminum bioavailability remains constant across exposure duration. Though EPA checked acute toxicity data against the MLR models, WDEQ/WQD questions whether this assumption is completely valid. WDEQ/WQD recommends that EPA evaluate MLR models based on acute toxicity data and compare these to current models. WDEQ/WQD also questions the appropriateness of using different assessment endpoints for each model, i.e., mean biomass endpoints for the fathead minnow and reproduction endpoints for the cladoceran. Similar to the concerns identified for criteria development, WDEQ/WQD believes that different endpoints represent different levels of organismal toxicity. Again, WDEQ/WQD recommends that EPA standardize data when possible and discuss the potential uncertainties that may arise when data are not standardized.*	Not all toxicity studies measure the same effects. Therefore, the EPA chooses the most sensitive endpoint based on growth, survival or reproduction, consistent with the 1985 Guidelines. Note: biomass is chosen over growth when available.	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0035 (Richard A. Hyde, P.E., Executive Director, Texas Commission on Environmental Quality (TCEQ))	Justification is needed to address the applicability of the MLR model, which was developed using results of chronic tests, to the development of acute toxic criteria. In the proposal, EPA states the "MLR equations applied to the acute toxicity data were developed through chronic tests, with the assumption that the effect of water chemistry on bioavailability remains the same." Achieving a high degree of confidence in the results of acute and chronic toxicity tests is inherently difficult, due to the large amount of variability that may be introduced while conducting the test, including but not limited to: (1) source and condition of test organisms, (2) known quality and condition of test waters, (3) control of laboratory conditions to conduct the test, (4) instrument calibration, and (5) training of laboratory staff. Incorporating the results of acute toxicity tests into the MLR model, including any evaluation of the differences in bioavailability, is needed due to the high potential for uncertainty already inherent in toxicity tests, and since exposure scenarios and endpoints are not consistent among acute and chronic tests. Information such as results of validations tests, or detailed information regarding the assumptions in the model may also be beneficial. Additionally, the EPA should elaborate on the use of "acute studies [that] did not report a definitive LC50 (i.e., yielded greater than values) because the highest concentration did not cause more than 50% mortality." Information such as extent of censored data, and a rationale explaining the relative impact to the toxicity dataset should be provided to describe this technical limitation. Use of the censored results may not be appropriate, if the amount of censored data comprising the dataset is substantial.	The EPA discusses the use of the chronic toxicity data evaluating the effects of water chemistry to acute data in the 2018 final aluminum criteria document; this approach reflects the extrapolation of the effects of water chemistry across test durations, reflecting the same assumptions in principle accepted in the 2007 Copper BLM-based criteria. The approach is the most scientifically-defensible approach at this time, based on available data. The toxicity data that were used in the development of the MLR models did not include censored data. Censored toxicity values were only included for a few species in the species sensitivity distribution; the inclusion was intended to provide the most complete data set to represent the range of taxa present in the environment. Use of "greater than" values follows the "decision rule" as described in the final aluminum criteria document (Section 3.1), as follows: “greater than” (>) low chronic values and “less than” (<) high chronic values were not used in the calculation of the SMCV; but “less than” (<) low chronic values and a “greater than” (>) high chronic values were included in the SMCV. This approach was also followed for acute SMAV calculations. The methodology is based on the finding that “greater than” values for concentrations of low magnitude, and “less than” values for concentrations of high magnitude do not generally add significant information to the toxicity analysis. In the 2018 Final Aluminum Criteria document in Section 3.1, all Species Mean Acute Value (SMAV) calculations were re-evaluated to verify that they adhere to the decision rule. This approach to the use of "greater than" values was initially described in the 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia in Freshwater and has continued to be applied in subsequent criteria.	No edits.
EPA-HQ-OW-2017-0260-0047 (Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))	NAMC notes that EPA applied the MLR based on the chronic dataset to normalize the acute dataset in the development of the acute MLR model. It is not clear whether this is the best approach to deriving acute criteria. NAMC requests EPA to compare this approach with the use of an acute to chronic ratio (ACR) used in reverse, i.e., use the MLR outputs divided by the ACR. EPA could also use the Biotic Ligand Model (BLM) to develop acute criteria for purposes of comparison and determining the best approach to generate the final acute value.		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*EPA's proposed criteria document uses a MLR based on chronic data to normalize the acute dataset. The justification behind this decision is lacking and more discussion on the validity of this application is needed. On page 37, EPA simply states that this was done, but provides no discussion or justification regarding whether or not that is a valid application of the MLR. Although such extrapolations are common from acute-to-chronic datasets (using acute-to-chronic ratios), we are not aware of any precedence for essentially doing this in "reverse". We suggest additional discussion from EPA on whether this is a valid application of the MLR.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*The Association notes that EPA applied the MLR based on the chronic dataset to normalize the acute dataset in the development of the acute MLR model. Acute-to-chronic dataset extrapolations are common, but not the reverse. Because this is a novel application of a chronic bioavailability model to acute data, the Association believes that additional explanation and/or verification steps are essential to confirm the validity of this approach. Below are several options that EPA should explore toward this end.* • *Use an acute-chronic ratio (ACR) in reverse to derive acute concentration predictions from MLR-normalized chronic criteria concentrations. There is precedent for this approach as used in the development of the copper BLM to derive chronic data from the acute BLM. As part of this approach, EPA should conduct validation of the draft criteria ACR as there are a significant number of unbounded acute values in the dataset provided.* • *Use the Biotic Ligand Model (BLM) to develop acute criteria for purposes of comparison with the proposed acute MLR model and use that comparison in determining the best approach to generating final acute values.* *More information on these options can be found in the attached GEI letter report.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*We recommend that EPA further explain or justify using a MLR based on chronic data to normalize the acute dataset. On page 37, EPA simply states that this was done, but provides no discussion regarding whether or not that is a valid application of the MLR. While such extrapolations are commonly done from acute to chronic criteria using acute-to-chronic ratios (ACRs), we are not aware that this has been done, effectively, "in reverse." Perhaps*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	EPA can also consider comparing acute MLR calculations against acute BLM calculations as a sensitivity analysis to further justify the accuracy or protectiveness of applying the chronic MLR to the acute data for purposes of calculating acute criteria.		
EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	*WDEQ/WQD is concerned with EPA's use of exceptions for the 1985 Guidelines. In addition to the example above, EPA also opted to use data for the fathead minnow that did not meet early life stage (ELS) requirements when developing the vertebrate MLR model (model discussed more below). In this instance, EPA states that the fathead toxicity values are comparable to acceptable ELS tests defined in the 1985 Guidelines, therefore their use in MLR model development is considered appropriate. WDEQ/WQD understands that appropriate data are not always available, however guidelines are in place to ensure consistency and defensibility. If exceptions are allowed, WDEQ/WQD requests that the 1985 Guidelines be revised to include the MDR exceptions or that EPA describe the exceptions in a formal, standalone document so they may be considered by other entities when developing water quality criteria.*	The 1985 Guidelines has a "best available science" clause that allows the EPA to pursue different avenues for criteria derivation, if they are scientifically defensible. The fathead minnow data identified by the commenter meets all appropriate data quality requirements to be used for criteria derivation, except that the exposure duration is not long enough (7 days versus 28 days). The data are therefore only used to develop bioavailability models for aluminum toxicity and are not included in Appendix C. Appendix C is Acceptable Chronic Toxicity Data of Aluminum to Freshwater Aquatic Animals and includes the data used in the species sensitivity distribution that has 28-day duration. These studies are vital for explaining the magnitude of differences seen in aluminum toxicity when water chemistry conditions vary between studies. However, the 7-day fathead minnow values were not included as core chronic data in the sensitivity distribution used to derive the criterion for aluminum because the exposure duration is too short compared to the other tests used in the sensitivity distribution, thus making relative sensitivity difficult to determine. The aluminum criteria document and the MLR models underlying the criteria were all subjected to independent external peer reviewed, with positive feedback.	No edits.
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*The MLR may be simpler than the biotic ligand model (BLM) to comprehend and apply but may not be as fully descriptive of the water quality variables driving aluminum ecotoxicity. A comparison such as depicted in the attached (Figure 1, for copper) would be beneficial to ensure the aluminum MLR provides reliable results in most cases, and to understand and provide guidance for the cases where there is discrepancy between the MLR and the BLM. It is possible such a comparison was made during criteria development and assessment, but if so the comparison is not presented in the document. EPA has not provided access to the database of values used in the MLR/BLM, preventing commenters from making this comparison independently.*	Current research on modeling indicates that the MLR and Biotic Ligand models have comparable performance in predicting aquatic toxicity for several chemicals, as long as both models are well-constructed and are supported with sufficient data. For example, Brix et al. (2017) concluded that the MLR and BLM models' performance for copper were comparable across a wide range of water chemistries and species (Environ. Sci. Technol., 2017, 51(9): 5182-5192). However, the aluminum BLM has not been updated with the new available data and has not been finalized. The EPA asked external expert peer reviewers to investigate the performance of the Aluminum BLM compared to MLR models that incorporated only pH and total hardness. Please	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		refer to the 2018 aluminum criteria web page (https://www.epa.gov/wqc/aquatic-life-criteria-aluminum#2018) or EPA docket for this information. Please also reference Section 5.3.5 for the rationale for why the EPA chose to pursue the MLR models published by DeForest et al. (2018a, b) over the BLM approach (Santore et al. 2018).	
EPA-HQ-OW-2017-0260-0046 *(Jennifer Wigal, Program Manager, Water Quality Standards & Assessments, Oregon Department of Environmental Quality)*	*In general, EPA chose assumptions that lead to more conservative outcomes in favor of more accurate outcomes in multiple steps of the criteria development process. At a minimum, EPA should evaluate, quantify, and report the uncertainty in criteria values that result from application of conservative assumptions they applied to multiple steps in the criteria development process, and provide the evidence that led them to conclude that conservative assumptions are necessary to protect aquatic life uses.* *Primarily, EPA used assumed Dissolved Organic Carbon (DOC) values to normalize the toxicity endpoints (i.e. EC20's) in the underlying toxicity studies when these were not reported in the studies themselves (p.37). It is unclear whether the estimated DOC values are meant to be accurate or conservative. It is also unclear how the use of assumed DOC concentrations in the toxicity studies impacts the accuracy of the resulting criteria. The effect of DOC on aluminum bioavailability is foundational to the models. The normalization of the toxicity data the criteria is based on should favor accuracy, rather than be conservative, if assumptions are necessary.* *EPA also assumes the DeForest et al. linear models that were developed for Pimephales promelas, and Ceriodaphnia dubia are generally applicable to all vertebrates and invertebrates, respectively. In addition, EPA also assumes that the DeForest et al. linear models, which were developed using only chronic toxicity endpoints, also adequately describe the response of acute toxicity to changes in DOC, hardness, and pH. EPA has identified these assumptions in Section 5.3 as a data gap.* *We understand that EPA compiled the best data available, and in some cases the ideal data is limited. However, DEQ is concerned by the number of assumptions made in the criteria, which include assumptions in the underlying toxicity data, assumptions upon which the sensitivity of different species are normalized by the models, and the expansion of the range of parameters beyond*	The DOC concentrations in the MLR equations used to normalize the toxicity data were all measured. The default DOC values used in the final 2018 aluminum criteria document, when measured concentrations were not reported by the external study authors for species in the sensitivity distribution, are the same as those found in Appendix C of the 2007 freshwater copper criteria document. These default DOC values were based on a scientific analysis of the different water types used in the studies. Authors of published studies were contacted, the USGS and the EPA databases were consulted, and city officials at drinking water plants were contacted to verify the default DOCs used. Please refer to Appendix C for more details (https://www.epa.gov/wqc/aquatic-life-criteria-copper), since these estimated values are meant to be as accurate as possible given the analysis. The best available data are being used at this time, and the EPA chooses to be clear and transparent with all assumptions. We consider the fathead minnow to be representative for other vertebrates, and that the cladoceran is representative for other invertebrates. In particular, the mechanisms of aluminum toxicity to fish based on bioavailability of aluminum are expected to be similar across freshwater species due to similarity in gill microenvironment among fathead minnows and other species (e.g., salmonids). It is well known that the solubility of aluminum decreases as pH is elevated in acidic water (ambient surface or gill microenvironment). Aluminum toxicity subsequently increases because aluminum polymerizes and accumulates on the gill surface. Thus, because of the similarity in the gill microenvironment among freshwater fishes in soft water, there is no reason to expect aluminum toxicity to be expressed differently in salmonids,	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	which the model is validated. Given that there are multiple assumptions made, starting with the most fundamental data, DEQ questions the level of confidence EPA holds in there being enough accurate information to formulate a valid criteria at this time. *We encourage EPA to consider refining the criteria by conducting additional studies to expand the underlying toxicity relationships, especially to address aluminum toxicity relative to DOC, and normalization models for additional species that may have a different toxic response from P. promelas and C. dubia.*	for example, as compared to the fathead minnow. The EPA also used the invertebrate *Ceriodaphnia dubia* as a surrogate for other invertebrates. The use of surrogate species to predict effects in other organisms is a standard practice in ecological risk assessment because toxicity data are typically limited.	
EPA-HQ-OW-2017-0260-0058 *(National Council for Air and Stream Improvement, Inc. (NCASI))*	*MLR model output is most sensitive to changes in DOC concentration (DeForest et al. 2017). Unlike pH, DOC is often not measured or measured with limited frequency, and unlike hardness there are no more easily obtained, measured parameters such as specific conductivity that correlate satisfactorily with DOC to provide adequate predictions of site specific DOC measurements [https://www.oregon.gov/deq/RulesandRegulations/Documents/BLM-TSD.pdf]. Because DOC is the most important input parameter affecting aluminum aquatic toxicity, it is suggested that EPA add language recommending that DOC values be measured rather than estimated when generating site specific aluminum water quality criteria.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*The draft criteria document uses 0.5 mg/L DOC (per the recommendations in the 2007 EPA copper criteria) for reconstituted laboratory waters where DOC was not measured. In the database used to develop the MLR, however, other values were used where DOC was not measured (e.g., 0.3 mg/L DOC was used for McCauley et al. 1983). Given the sensitivity of the MLR to DOC, the default value used has a very significant effect on the resulting criteria after normalization, even for a seemingly small reduction in the default from 0.3 from 0.5 mg/L, As stated in Appendix C of the 2007 copper criteria document, "[t]he recommended default TOC (DOC) value for laboratory prepared reconstituted water is 0.5 mg carbon/L (note: some newer laboratory water systems can achieve a TOC of less than 0.5 mg/L)." The draft criteria would benefit from discussion on the selection of 0.5 mg/L DOC, as opposed to lower values used to develop the MLR, for the purposes of normalizing water chemistry. Our recommendation is that EPA consider using 0.3 mg/L as a default value for unmeasured DOC values.*	The 2007 freshwater copper criteria document's Appendix C recommendations note, "For tests with reconstituted, city tap, or well water, default DOC values can be applied if the author does not report a measured value. The recommended default TOC (DOC) value for laboratory prepared reconstituted water is 0.5 mg carbon/L (note: some newer laboratory water systems can achieve a TOC of less than 0.5 mg/L). The recommended default value for laboratory-prepared reconstituted water is based on the arithmetic mean of recent measurements of DOC in reconstituted water prepared at two Federal (U.S. EPA Cincinnati, OH, and USGS Yankton, SD) and two consulting (Commonwealth Biomonitoring and GLEC) laboratories (range 0.1 to 1 mg/L)." Based on this analysis and to be consistent with other published AWQC recommendations, the default DOC value of 0.5 mg/L, for reconstituted water will stay the same. When	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		the author reports a value, that value will be used. Additionally, if the author reports a less than value, half that value will be used.	
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	*ADEC is concerned that the multiple linear regression (MLR) model will not adequately address the complexity of water chemistry found in Alaskan waters. Diverse geologic, topographic and hydrologic features, including the presence of permafrost, will affect the fate and transport of aluminum. The current version of the MLR model development bounds the upper limits of dissolved organic carbon (DOC) at 5 mg/L; Alaska has surface waters that naturally exceed this concentration. ADEC requests EPA expand on the existing model's upper limits to take into account waters with greater physicochemical ranges.*	Thank you for your comment. Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. The total hardness of toxicity test waters ranged from 9.8 to 428 mg/L. The DOC of toxicity test waters ranged from 0.08 to 12.3 mg/L. The pH of toxicity test waters ranged from 6.0-8.7. As a result, the recommended bounds have changed. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5. For hardness values, the criteria calculator allows entry of values between 0.01 and 430 mg/L total hardness; criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). For DOC, the criteria calculator will not extrapolate below the lowest empirical DOC of 0.08 mg/L and upper limit of the empirical MLR models will be bounded at a maximum 12.0 mg/L DOC in the criteria calculator; criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L.	No edits.
EPA-HQ-OW-2017-0260-0014 *(David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))*	*The draft 2017 aluminum criteria also accounts for the influence of other water quality parameters on aluminum toxicity. Using the results from previous studies, EPA developed MLR models that normalize aluminum toxicity data for invertebrate and vertebrate taxa as a function of ambient measurements of pH, hardness as calcium carbonate (CaCO3), and dissolved organic carbon (DOC). The invertebrate and vertebrate MLR models were derived based solely on chronic toxicity data for the cladoceran, Ceriodaphnia dubia, and the fathead minnow, Pimephales promelas, respectively.* *After reviewing the MLRs, WDEQ/WQD's initial concern is the applicability of such species-specific models to broader invertebrate and vertebrate taxonomic groups. Further, neither C. dubia nor P. promelas are among the most sensitive taxa used to derive criteria values at a normalized pH of 7, hardness of 100 mg/L and DOC of 1 mg/L. EPA does not present any information on how the MLRs would be representative of other species and/or genera and acknowledges that including other species would improve model representativeness, notably for the invertebrate*	Thank you for your comments. It is common when evaluating effects on organisms to use surrogate species to represent untested species. Surrogate species are typically used as indicators of how other species will respond. The EPA does note the uncertainty surrounding this approach. The mechanisms of Al toxicity to fish based on bioavailability of aluminum are expected to be similar across freshwater species due to similarity in gill microenvironment among fathead minnows and other species (e.g., salmonids). It is well known that the solubility of aluminum decreases as pH is elevated in acidic water (ambient surface or gill microenvironment). Aluminum toxicity subsequently increases because aluminum polymerizes and accumulates on the gill surface. Thus, because of the similarity in the gill microenvironment among freshwater fishes in soft water, there is no reason to expect aluminum toxicity to be expressed differently in salmonids, for example, as compared to the fathead minnow. The EPA also used the invertebrate *Ceriodaphnia dubia* as a surrogate for other invertebrates.	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	MLR due to arthropod diversity. Therefore, prior to finalizing the models and criteria, WDEQ/WQD recommends that EPA explore how other taxa may respond to varying levels of pH, hardness and DOC. Without such an analysis, there remains fundamental uncertainty regarding the applicability of the recommended criteria to other taxa.	The use of surrogate species to predict effects in other organisms is a standard practice in ecological risk assessment because toxicity data are typically limited. Further, the EPA submitted the document to independent, external peer review, with a favorable outcome.	
EPA-HQ-OW-2017-0260-0014 (David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))	*WDEQ/WQD's final concern with model development are the limited ranges for input values. EPA developed the MLR models within the ranges of 5.0 - 9.0 SU, 9.8 - 127 mg/L and 0.08 - 5.0 mg/L for pH, CaCO3 and DOC, respectively. EPA cautions model users to avoid using higher or lower input values since these may yield limited or extrapolated criteria values. WDEQ/WQD questions the applicability of the MLRs to Wyoming surface waters and requests that EPA elaborate on how the models/criteria are to be used if ambient measures of pH, CaCO3 and DOC fall outside of the input ranges.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. For the 2018 final criteria, the total hardness of toxicity test waters ranged from 9.8 to 428 mg/L. The DOC of toxicity test waters ranged from 0.08 to 12.3 mg/L. The pH of toxicity test waters ranged from 6.0-8.7. As a result, the recommended bounds have changed. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5. For hardness values, the criteria calculator allows entry of values between 0.01 and 430 mg/L total hardness; criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). For DOC, the criteria calculator will not extrapolate below the lowest empirical DOC of 0.08 mg/L and upper limit of the empirical MLR models will be bounded at a maximum 12.0 mg/L DOC in the criteria calculator; criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L.	No edits.
EPA-HQ-OW-2017-0260-0021 & EPA-HQ-OW-2017-0260-0022 (Daryll Joyner, Administrator, Water Quality Standards Program, Florida Department of Environmental Protection (DEP))	*While the pH range covered by the proposes Al criteria covers the general range expected in natural freshwaters, the range of DOC addressed by the proposed criteria is very limited and well below the levels typically found in the majority of Florida freshwaters. More than 90 percent of Florida's lakes and streams have DOC concentrations about the 5 mg/L upper limit used in the proposed criteria. Similarly, approximately 35 percent of Florida's streams have hardness levels above the 150 mg/L upper limit for the proposed criteria. The limited ranges of DOC and hardness incorporated into the proposed criteria would result in Al criteria that are more stringent than required for the protection of many Florida freshwaters. Therefore, DEP recommends that EPA conduct the necessary studies to expand the range of hardness and especially DOC covered prior to finalizing the proposed criteria.*		
EPA-HQ-OW-2017-0260-0023 (Stan Dempsey Jr., CMA President, Colorado Mining Association (CMA))	*The Multiple Linear Regression (MLR) model is a significant improvement over EPA's current recommended criteria because it accounts for changes in pH, hardness, and DOC and the effect that they have on toxicity. For hardness and DOC, the EPA limited the criteria to the range of hardness and DOC that was used in the MLR studies. However, for pH EPA attempts to expand the range beyond what was used in the MLR studies. The MLR studies did not include a pH range below 6.0 or above 8.1. Applying the model beyond these boundaries is unacceptable. EPA needs to apply pH limitations similar to how hardness and DOC were handled in the criteria calculation. If the pH of water is beyond the range, then the criteria should be calculated with a pH level equal to the upper*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria were thus expanded, with details and rationale provided in the criteria document and summarized below. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5. For hardness values, the criteria calculator allows entry of values between 0.01 and 430 mg/L total hardness; criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). For DOC, the criteria calculator will not extrapolate	

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	or lower extent of the range. For example, if pH of the water is 9.5, the criteria should be calculated with a pH of 8.1, which is equal to the upper extent of the MLR model.	below the lowest empirical DOC of 0.08 mg/L and upper limit of the empirical MLR models will be bounded at a maximum 12.0 mg/L DOC in the criteria calculator; criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L.	
EPA-HQ-OW-2017-0260-0025 (Peter T. Goodmann, Director, Kentucky Division of Water)	*The pH for the draft recommended aluminum criteria is bound in the 5.0 to 9.0 pH range, however, some waters, especially in areas with historical resource extraction activities, will experience pH outside of this range. The draft does not indicate how the recommended criteria apply when the stream pH is outside of the range. The division believes that further clarity or guidance is needed for these conditions.*		
EPA-HQ-OW-2017-0260-0027 (Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))	*CASQA requests that the final criteria extend the range for the DOC parameter. DOC is one of the most sensitive parameters of the criteria calculation methodology. As DOC increases, the bioavailability of aluminum decreases, resulting in lower criteria for the waterway being evaluated. As proposed in the Aluminum Notice, the maximum DOC is 5.0 mg/L. However, many waterways in California have significantly higher concentrations of DOC. An assessment of natural (i.e., un-impacted) streams in Southern California found natural background concentrations of DOC above 5 mg/L (flow-weighted) in ten of the 14 streams during wet weather. [Stein, E. and V. Yoon. 2007. Assessment of Water Quality Concentrations and Loads from Natural Landscapes. Southern California Coastal Water Research Project Technical Report 500, Appendix VIII. February.] Three of the streams had DOC concentrations above 20 mg/L. (See Attachment A). A study of the Los Angeles River found that all dry weather and wet weather samples from the main stem and tributary sites exceeded 5 mg/L. [Larry Walker Associates. 2014. Final Report Copper Water-Effect Ratio Study to Support Implementation of the Los Angeles River and Tributaries Metals TMDL. April.] In the proposed criteria, the Multiple Linear Regression (MLR) criteria outputs are bounded at a maximum DOC of 5.0 mg/L because the available toxicity data did not extend beyond 5 mg/L. Securing the additional toxicity data will require additional time, however, it will allow a more accurate assessment of bioavailability and decrease the potential for California waterways being erroneously identified as impaired by aluminum.* *We also note that a peer reviewer indicated that more data would be needed to calibrate the model, especially for higher DOC values, before using the model for regulatory purposes. This data is needed to represent commonly encountered natural*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	environmental conditions. As currently proposed, the DOC range is not representative of California waterways.		
EPA-HQ-OW-2017-0260-0027 (Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))	*Increasing hardness generally has the effect of decreasing the toxicity of metals and this is true for aluminum. Aluminum is substantially less toxic at higher levels of hardness. Similar to DOC, the MLR criteria outputs for hardness are bounded such that it will not be possible to accurately assess site-specific conditions for many California waterways. The maximum total hardness used as input in the MLR is 150 mg/L as CaCO3. This is because the toxicity input data for developing the model ranged from 9.8 to 127 mg/L. Limiting the hardness used in the MLR to 150 mg/L results in toxicity being overestimated for values above 150 mg/L. Many waterways in California have hardness values above the maximum assessed in developing the proposed criteria. For example, median values for dry weather hardness in the Los Angeles River are shown below and significantly exceed the 150 mg/L cap. [Ibid. Excerpted from Table 2-6 (source: City of Los Angeles WMP). Also see Table A-3.]. Similarly, average hardness in the Santa Ana River averages between 220-350 mg/L. [Santa Ana Watershed Project Authority (SAWPA). 2012. 2011 Annual Report of Santa Ana River Water Quality. August.]* *Other approved standards have been based on higher limits for hardness. Colorado's revised water quality standards were approved by EPA Region 8 in 2011. These standards provide an example of the effect of hardness values above the 150 mg/L cap used in the Aluminum Notice. [Colorado Dept. of Public Health and Environment - Water Quality Control Commission. Regulation No. 31: Basic Standards and Methodologies for Surface Water (5 CCR 1002-31). Effective March 1, 2017. See Table IV: Table Value Standards for Selected Hardnesses. https://www.colorado.gov/pacific/sites/default/files/31_2017-03.pdf Note: Table III – Metal parameters indicates that the aluminum criterion is based on total recoverable. Table IV, however, incorrectly includes the following in parenthesis in the title: concentration in ug/L, dissolved. Use of total recoverable is correct for aluminum in Colorado based on the discussion on page 196] The Colorado criteria apply to total recoverable aluminum, but unlike the 1988 EPA criteria, they are adjusted for hardness. [The previous Colorado standards included the EPA 1988 acute and chronic recommended criteria of 750 µg/L and 87 µg/L for total aluminum, respectively, except that the 87 µg/L chronic*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	criterion did not apply when the pH was ≥ 7 and hardness ≥ 50 ppm.] They are not adjusted for DOC. The hardness cap used in Colorado is 220 mg/L rather than the 150 mg/L used in the Aluminum Notice. The following table shows the Colorado criteria for selected hardness values. *[TABLE]* *Excerpted from Table IV – Table Value Standards for Selected Hardnesses; the upper cap on the calculations is a hardness of 220 mg/l; where pH is less than 7.0 in the receiving water after mixing, either the 87 µg/l chronic total recoverable aluminum criterion or the criterion resulting from the chronic hardness-dependent equation will apply, whichever is more stringent.* *As seen in the table above, increasing the maximum of the hardness range to 220, as was done in Colorado, significantly increases the acute and chronic criteria due to the decrease in bioavailability. For aluminum, the equations are valid only for dissolved hardness concentrations of 0-220 mg/L. For dissolved hardness concentrations above 220 mg/L, the aluminum criteria for 220 mg/L apply.* *The new standards reflected in the table above were approved by EPA Region 8 in 2011. [U.S. EPA-Region VIII (Carol L. Campbell, Asst. Regional Administrator; Office of Ecosystems Protection and Remediation). Letter to Peter Butler, Chairman of the Colorado Water Quality Control Commission Approving the 2010 Revisions to the Basic Standards and Methodologies for Surface Water. August 4, 2011. https://www.colorado.gov/pacific/sites/default/files/2011EPAaug4.31.pdf] EPA stated:* *Although the revised table value standards for aluminum are substantially different from CWA§ 304(a) recommendations for aluminum [i.e., 1988 criteria], EPA agrees that the revised standards are scientifically defensible and protective of aquatic life.* *In the approval letter, EPA included a comparison of acute toxicity data with the 1988 EPA acute criterion of 750 µg/L and the new Colorado hardness dependent criterion.*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	[FIGURE] *Excerpted from EPA 8 August 4, 2011 letter approving revised water quality standards in Colorado.* *As seen in the figure, the Colorado hardness-adjusted acute criteria are protective at the higher levels of hardness based on the available toxicity data.* *More testing will be needed to establish new aluminum criteria capable of assessing higher levels of hardness together with DOC. Nevertheless, the results will allow a more accurate assessment of risk in waterways with relatively high levels of hardness, such as those in California.*		
EPA-HQ-OW-2017-0260-0029 *(Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))*	*The draft criteria were developed using multiple linear regression (MLR) models to predict the toxicity of aluminum as a function of multiple combinations of pH, hardness, and DOC conditions. (Draft at xi) based on 22 chronic tests with fathead minnows and 23 chronic tests with Ceriodaphnia dubia. The resulting MLR criteria are bounded at a maximum of 150 mg/L hardness and 5.0 mg/L DOC, to reflect the bounds of the underlying model data, whereas the pH covers the range of 5.0 to 9.0.* *It should be noted that the MLR criteria outputs are <u>bounded</u> at a maximum of 150 mg/L total hardness, as CaCO3, and DOC of 5.0 mg/L, <u>because the available toxicity data did not extend beyond these maxima</u> (input data ranged from 9.8 to 127 mg/L for hardness and 0.08 to 5 mg/L for DOC). The user can input values for areas with hardness greater than 150 mg/L and DOC of 5 mg/L, but the criteria output for these parameters will be limited at the bounds stated due to underlying data limitations. The <u>pH range of the model is from 5.0 to 9.0, extending beyond the range of empirical data used for model development</u> (pH 6.0 to 8.1). This is provided to be protective of a broader range of natural waters; <u>however, values estimated outside of the range of the data are more uncertain</u>. (Draft at xii) (Emphasis added)* *The criteria values outside of the model input data range are more stringent than those within the model input range under the same hardness and DOC conditions and have greater uncertainty. (Draft at 57)*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	As discussed, factors that tend to mitigate the toxicity of aluminum (hardness and DOC) were bounded based on the range of concentrations present in the toxicity database used to develop the criteria. The pH range, however, was extended beyond the empirical data range. The rationale presented for extending the pH range is to be protective, but as noted, results in predictions that are more uncertain because they lie outside the range that was evaluated. Given this acknowledgement of uncertainty, the proposed criteria should also include a footnote indicating that use of a water effect ratio may be appropriate where the ambient pH, hardness, or DOC falls outside the testing boundaries used for the development of the revised criteria.		
EPA-HQ-OW-2017-0260-0032 *(Phillip M. Gonet, President, Illinois Coal Association (ICA))*	*The Multiple Linear Regression (MLR) predicts the toxicity of aluminum based on the level for pH, hardness, and DOC. The Draft Criteria points out that the studies used to develop the MLR had a pH range of 6.0 - 8.1 standard units. The criteria should be limited to this pH range and should not be extrapolated beyond it. The reliability of MLR models results is uncertain above a pH of 8.1 or below a pH of 6.0.*		
EPA-HQ-OW-2017-0260-0034 *(James Boswell, Senior Manager, Environmental, Peabody Energy)*	*The draft criteria have an upper bound for hardness of 150 mg/L. Peabody agrees that this is appropriate based on the empirical data that was incorporated into the MLR model. However, this limitation reduces the models representativeness in regions with high hardness. Coal mining facilities are located in sedimentary rock deposits which often have high hardness levels under natural conditions. The coal mining process of blasting and mixing the overburden strata increases the hardness further, to levels in excess of 150 mg/L. As a reference, the sites provided in Table 1 showed hardness ranges of 21-824 mg/L in New Mexico, 36 – 3,838 mg/L in Arizona, and 130 – 818 mg/L in Colorado. The hardness limit significantly underestimates the hardness ranges seen in the environment, including the undisturbed environment characterized by these concentration ranges. Generally speaking, for most metals criteria increased hardness is associated with reduced toxicity to aquatic organisms. As such, limiting the criteria to a hardness of cap of 150 mg/L likely does not account for this phenomenon at higher hardness levels. EPA needs to examine opportunities to expand the hardness range of the criteria. For example, aluminum criteria that were developed in the western states of New Mexico and Colorado had an upper bound for hardness of 220 mg/L, based on data from Kimball (1978) that is*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	also cited in the draft criteria. EPA should determine if these or other data can be incorporated into the criteria development that could expand upon the range of hardness.		
EPA-HQ-OW-2017-0260-0034 *(James Boswell, Senior Manager, Environmental, Peabody Energy)*	*The draft criteria sates that the MLR model was based on empirical data with a pH range of 6.0 to 8.1 standard units. The draft criteria go on to expand the pH range of the model from 5.0 to 9.0 standard units to "be protective of a broader range of natural waters". Peabody notes that the resulting aluminum criteria reduce exponentially at pH levels less than 6 and greater than 8. This questions whether it is appropriate to expand the model beyond the data boundaries that it was originally based on. This is particularly suspect considering the significant reducing effect that the higher and lower pH levels have on the resulting criteria. EPA should limit the applicability of the criteria to the bounds for pH (6.0 – 8.1) just as it did for hardness and DOC, where the criteria remains constant at pH values above and below those bounds. The extrapolation that EPA is currently proposing above and below this pH range is not scientifically valid.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the water chemistry bounds for the 2018 criteria were thus expanded, with details and rationale provided in the criteria document and summarized below. The criteria calculator can be used to address waters within a pH range of 5.0 to 10.5. For hardness values, the criteria calculator allows entry of values between 0.01 and 430 mg/L total hardness; criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). For DOC, the criteria calculator will not extrapolate below the lowest empirical DOC of 0.08 mg/L and upper limit of the empirical MLR models will be bounded at a maximum 12.0 mg/L DOC in the criteria calculator; criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L. The pH of toxicity test waters ranged from 6.0-8.7. The EPA has determined that for pH it is reasonable to allow the user to extrapolate beyond these values for criteria derivations. The criteria calculator can be used to address all waters within a pH range of 5.0 to 10.5. Thus, criteria values for pH input values beyond the range of the underlying empirical pH data used for model development (pH 6.0 to 8.7) can be generated using the criteria calculator. (This is also reflected in the criteria lookup tables in Appendix K of the 2018 Final Aluminum AWQC document). The EPA took this approach for pH so that the recommended criteria can be provided for, and thus are protective of, a broader range of U.S. natural waters. Extrapolated criteria values outside of the empirical pH data tend to be more protective of the aquatic environment (i.e., lower criteria values) in situations where pH plays a critical role in aluminum toxicity. However, criteria values generated outside of the range of the pH conditions of the toxicity tests underlying the MLR models are more uncertain than values within the pH conditions of	No edits.
EPA-HQ-OW-2017-0260-0035 *(Richard A. Hyde, P.E., Executive Director, Texas Commission on Environmental Quality (TCEQ))*	***B. The TCEQ recommends expanding the range of possible measurement inputs in the proposed Multiple Linear Regression (MLR) model which has limited applicability in Texas waters.*** *The MLR model as proposed by the EPA is not reflective of water chemistry observed in western surface waters, such as Texas. As currently proposed, the MLR model criteria outputs are constrained by total hardness of 150 mg/L as* $CaCO_3$*, and Dissolved Organic Carbon (DOC) at 5.0 mg/L. These constraints limit the utility and applicability of the model in Texas, where total hardness values and DOC may exceed 1,525 and 270 mg/L, respectively. The EPA should adjust the model as needed to increase its applicability, or provide options for states to allow local water chemistry of surface waters to be incorporated. Adjustment may result in changes to the EPA's proposal.*		
EPA-HQ-OW-2017-0260-0036 *(Barry N. Burnell, Water Quality Division Administrator, State of Idaho Department of Environmental Quality (DEQ))*	*DEQ is concerned with the upper bounds of 5 mg/L for dissolved organic carbon and 150 mg/L as* $CaCO_3$ *for hardness. A hardness of 150 mg/L as* $CaCO_3$ *represents the* 73^{rd} *percentile of hardness collected from stream and river sites sampled throughout Idaho in the summer of 2016 [DEQ (Idaho Department of Environmental Quality). 2017. Statewide Monitoring for Inputs to the Copper Biotic Ligand Model. Boise, ID: DEQ. http://www.deq.idaho.gov.media.60180618/58-0102-1502-statewide-monitoring-inputs-copper-biotic-ligand-model-0817.pdf]. EPA should consider expanding the model's bounds for*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	both hardness and DOC.	the MLR toxicity tests, and thus should be considered carefully and used with caution. The total hardness of toxicity test waters underlying the MLR models ranged from 9.8 to 428 mg/L. Since a decrease in total hardness tends to increase aluminum toxicity, the EPA has determined it is reasonable to extrapolate on the lower bound of the hardness data to enable generation of lower criteria at low hardnesses beyond the limit of the empirical data. Thus, hardness input values in the criteria calculator can be entered that are less than 9.8 mg/L down to a limit of 0.01 mg/L. This is consistent with existing EPA approaches to low end hardness (U.S. EPA 2002). However, criteria values are bounded at the approximate upper limit of the empirical MLR models' underlying hardness data, at a maximum of 430 mg/L total hardness (as $CaCO_3$). The user can input hardness values into the criteria calculator that are greater than 430 mg/L for total hardness, but the criteria magnitude will reach its maximum value at 430 mg/L total hardness (as $CaCO_3$), and criteria magnitudes will not increase or decrease by increasing the hardness above 430 mg/L total hardness (as $CaCO_3$). This is also consistent with existing EPA guidance on high end hardness "caps" (U.S. EPA 2002). (These total hardness bound approaches are also reflected in the criteria lookup tables in Appendix K of the 2018 Final Aluminum AWQC document.) The EPA took this approach so that the recommended criteria can be provided for, and will be protective of, a broader range of U.S. natural waters. Criteria values generated beyond the lower bound of the hardness conditions of the toxicity tests underlying the MLR models are more uncertain than values within the hardness bounds of the MLR toxicity test data. The DOC of toxicity test waters ranged from 0.08 to 12.3 mg/L. Since most natural waters contain some DOC, the lower bound of the empirical toxicity test data (0.08 mg/L) is the lowest value that can be entered into the criteria calculator; thus, no extrapolation below the lowest empirical DOC of 0.08 mg/L is provided. The criteria values generated with the criteria calculator are bounded at the upper limit of the empirical MLR models' underlying DOC data, at a maximum 12.0 mg/L DOC. The user can input DOC values	
EPA-HQ-OW-2017-0260-0037 *(Anonymous public comment)*	*EPA extended the pH range of the proposed aluminum calculator (5-9) beyond the range of reliable data (~6-8) to be more protective of water bodies. EPA did not extend the range of DOC above 5 mg/L. Discharges to high DOC water may be held to a more conservative standard than is necessary. EPA should address the fairness of extending the range of only one parameter (pH) beyond reliable scientific data. Why should there not be a similar extrapolation to higher DOC values (>5 mg/L)?*		
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	*The maximum dissolved organic carbon (DOC) limit for the new calculator is 5 mg/L. Some water bodies have significantly higher DOC and therefore potentially significantly higher toxicity limits. It would be an undue hardship for a permittee discharging to a water body with high DOC to be required to meet an unreasonably low Aluminum limit just because the scale of the model maxes out at 5 mg/L for DOC. The model should be expanded to account for higher DOC concentrations observed in New England waters.*		
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	*EPA should provide updated guidance for performing calculations and/or studies to determine higher regulatory Aluminum toxicity limits when water bodies are not within the calculator's limits for pH, hardness, and DOC.*		
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*The user-friendly Aluminum Criteria Calculator appears to be a useful tool, but some of the parameters, particularly Dissolved Organic Carbon (DOC), do not fully encompass all ambient conditions in our member states. We request that the model parameters be expanded to reflect the full range of observed concentrations in our states' surface waters, for example Massachusetts's values for DOC tend to fall between 3 and 12 mg/L, with median values of 6.0 mg/L. Based on the model's upper boundary of 5 mg/L DOC, it does not adequately represent the range of conditions in all waters. Appendix K offers a broader range of input values for pH and Hardness. The addition of these into the calculator, along with expanded parameters for DOC would be of valuable.*		
EPA-HQ-OW-2017-0260-0042 *(Bruce A. Stevens, President, Indiana Coal Council, Inc. (ICC))*	*The Multiple Linear Regression (MLR) accounts for changing toxicity based on the pH, hardness, and DOC of the water column. The Draft Criteria points out that the studies used to develop the MLR had a pH range of 6.0 – 8.1 standard units. But the EPA goes on to expand the pH range beyond what was used in the MLR studies. The MLR was not validated above a pH of 8.1 or below a*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	pH of 6.0. There is significant uncertainty in model predictions above a pH of 8.1. For pH levels below 6.0, singling out toxic effects from aluminum is complicated by the toxic effects of the acidity of the water. EPA should not expand the model beyond the pH range of 6.0 – 8.1.	greater than 12.0 mg/L into the calculator, but the criteria magnitude will reach its maximum value at 12.0 mg/L DOC, and criteria magnitudes will not increase or decrease by increasing the DOC above 12.0 mg/L. This is also reflected in the criteria lookup tables in Appendix K of the 2018 Final Aluminum AWQC document. This is consistent with the existing approach for hardness (U.S. EPA 2002) to provide for protection of aquatic organisms through the use of protective, conservative values when water chemistry conditions are beyond the upper limits of the empirical toxicity test data. Please work with your local EPA Region and Headquarters' staff to regarding any refinements sought for situations where water chemistry for a particular water falls outside the bounds of the model.	
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*The bounds of inputs to populate the model were 9.8 mg/L to 127 mg/L for total hardness, 0.08 mg/L to 5.0 mg/L for dissolved organic carbon (DOC) and 6.0 to 8.1 for pH. However, the extent in which the guideline applies to, for pH and hardness, extends beyond the range of empirical data used for model development. The guidance should not assert or assume knowledge of toxic responses beyond the range of empirical data used for model development. Toxicological studies have been clear that expanding the boundaries of a study beyond that in which the toxicology supports is not defensible. Linear regression as it pertains to toxicological responses can vary drastically beyond the scope of the study parameters and it would be inappropriate to simply extend the bounds of applicability without sufficient demonstration.* ***The State of New Mexico does not have adequate information, from what was provided by EPA in the proposed guidance, to ascertain the reasoning or defensibility for extending the reaches of the criteria beyond the scope of the study, and without such demonstration cannot support this assertion.***		
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*The 1988 guidance expressly excluded waters with pH values below 6.5 or above 9.0. This proposed guidance does not provide any additional input on the limits to which aluminum toxicity impacts aquatic life in waters with pH values below 6.0 and above 8.1. The linear regression model, as proposed extends beyond the scope of the data to include pH values ranging from 5.0 to 9.0; however, this assertion is not defensible as it is known that toxicology in these outlying pH ranges changes drastically from the circumneutral zone.* *The findings in older primary literature regarding the influence of alkaline pH on toxicity seems mixed (Gundersen et al., 1994, Gensemer & Playle, 1999), yet the MLR model becomes more protective as one progresses from circumneutral pH to the more alkaline range. A review of the literature regarding aluminum toxicity at alkaline pH suggests equivocal effects at best, but trend toward less toxic aluminum forms as waters become more alkaline. Colorado (prior to adopting hardness-based criteria) and North Dakota (currently) incorporate(d) EPA's 1988 guidance with the*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	caveat that the chronic criteria would not apply at high pH, or with appreciable water hardness, due to the low toxicity of aluminum at this pH range. ***The State of New Mexico would like the guidance to include defensible aluminum criteria for waters with pH values below 6.0 and above 8.1***.		
EPA-HQ-OW-2017-0260-0046 *(Jennifer Wigal, Program Manager, Water Quality Standards & Assessments, Oregon Department of Environmental Quality)*	*The multi-linear regression model by DeForest et al. (2017), upon which the criteria are based, was validated to a pH range of 6.5 - 8.0, hardness of 9.8 - 127 mg/L, and DOC of 0.1 - 5 mg/L. In the criteria, EPA extrapolates the range of pH inputs from 5.0 - 9.0, more than doubling the validated pH range. We also note EPA chose not to extrapolate hardness and DOC to higher ranges, even though these would more accurately reflect aluminum bioavailability in a more natural range of water quality conditions because this would make the resulting criteria less stringent.* *DEQ is concerned that EPA recommends using the calculator to generate criteria values for conditions outside the pH range validated for the DeForest et al. model, particularly because conditions outside the validated model limits (i.e. changing from a pH of 6.5 to 5) have a very large impact on the resulting criteria values for aluminum that should be justified. For example, using statewide median concentrations in Oregon for DOC (1.8 mg/L) and hardness (35 mg/L) as reference values, the criteria values change dramatically with pH. At pH 6.5, the lower bound of the DeForest validation, the CCC under these median conditions is 310 µg/L. At pH 5, the range to which EPA extrapolated the model, the CCC is 6.1 µg/L. This change brings the criterion far below typical natural background levels of aluminum found in Oregon waters.* *Criteria values of this low magnitude are driven by pH values not validated by either the DeForest et al. model nor represented in the underlying toxicity data. EPA did not cite the evidence that led them to suggest criteria values in the extrapolated range of pH are necessary to protect the use, nor how certain they are in the accuracy of these criteria values. EPA should provide this evidence or limit the model to pH ranges supported by the data and model.* *In addition, the pH water quality standard in Oregon is 6.5 to 9.0. In western Oregon, it is not uncommon to see naturally occurring pH levels as low as 6 due to rainfall. If pH drops below 6, it is*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	most likely the pH impairment, rather than the aluminum concentration, that should be corrected. Extrapolating the model to a range of pH 6.0 - 9.0 would be more supportable than the current range. It would better align with the state's pH criteria, and reflects the range of natural conditions experienced in Oregon.		
EPA-HQ-OW-2017-0260-0047 *(Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))*	*NAMC supports the EPA proposal to cap the model input hardness values at 150 mg/L and model input dissolved organic carbon (DOC) values at 5 mg/L based on the uncertainty of modeling predictability above those thresholds. NAMC recommends that a similarly restricted approach to model input pH should also be pursued. The MLR is fully validated between pH 6 and 8.1, which encompasses the range of most water bodies. In the draft criteria, EPA extrapolates model performance up to waterbody pH 9.0 at which the model predicts increasing toxicity up to pH 9.0. When modeling in the range of pH 8.1 to pH 9.0, there is significant uncertainty in the model's predictions as the speciation of dissolved aluminum changes considerably in this pH range to favor more strongly the aluminate anion. The binding of aluminate to gill surfaces has not been fully evaluated. NAMC recommends that if a waterbody pH is greater than pH 8.1, a value of 8.1 should be entered into the model and the resulting model output would be used to set the aluminum water quality criteria limit for that waterbody.* *NAMC has similar concerns with using the model for lower pH ranges. The MLR is not validated in the range of pH 5.0-6.0. It is likely that toxicity would be greater as the pH decreases below pH 6.0 due to increasing concentrations of Al^{+++}, however, resulting toxicity is due to both hydrogen ion content as well as aluminum, which would mitigate any increases in toxicity with decreasing pH. NAMC requests that EPA set a floor of pH 6.0 for model usage with the recognition that this still provides an expansion of modeling applicability below the 1988 pH floor of 6.5.*		
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*The multiple linear regression (MLR) models in the EPA's criteria document were based upon empirical toxicity test data developed with laboratory waters having a pH range of 6.0 to 8.1, hardnesses of 9.8 to 127 mg/L as $CaCO_3$, and dissolved organic carbon (DOC) concentrations of 0.8 to 5 mg/L (page xii of draft criteria document). USEPA expresses that they are not extending beyond the values for hardness and DOC, because the model data was not available. However, the document states that the MLR does*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	extrapolate pH values beyond the range of the available data, but there is no explanation or basis for this decision or the accuracy and protectiveness of the approach. Based upon the limitations of the empirical data and the effect of the approach on the site-specific criteria, we recommend that USEPA limit the pH input values as they have done for hardness and DOC.		
EPA-HQ-OW-2017-0260-0050 (J. Tyler White, President, Kentucky Coal Association (KCA))	*The Draft Criteria itself notes that studies used to develop the MLR had a pH range of 6.0 - 8.1, yet the Draft Criteria expands the range to 5.0- 9.0. There is an insufficient basis apply the criteria to waters with a pH outside the range of 6.0 - 8.1.*		
EPA-HQ-OW-2017-0260-0051 (Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))	*The MLR models were developed using data that encompass a pH range of 6-8.1, DOC range of 0.08-5 mg/L and hardness range of 9.8-127 mg/L (as CaCO). MLR criteria outputs are bounded at a maximum of 150 mg/L total hardness and a DOC of 5.0 mg/L because available toxicity data did not extend beyond these maxima. The user can input values of hardness greater than 150 mg/L and DOC greater than 5 mg/L, but criteria output will be limited to these bounds due to underlying data limitations during model development. The hardness and pH values that were selected for this analysis appear to be representative of the surface water quality conditions in Massachusetts; however, the upper boundary of 5 mg/L DOC does not adequately represent the range of conditions in Massachusetts' waters. MassDEP supports the incorporation of pH, hardness and DOC into the model, but has concerns about the maximum range of DOC.* *To evaluate the impact of the potential criteria, MassDEP reviewed available data for hardness, pH, and organic carbon in Massachusetts streams from the U.S. Geological Survey (USGS) National Water Information System (NWIS) database (https://waterdata.usgs.gov/nwis).* *A total of 6,462 samples had been analyzed for one or more of pH, hardness, DOC, or total organic carbon (TOC). USGS averaged the values for each parameter at each site yielding the following number of data points per parameter: 556 for hardness, 765 for pH, 158 for DOC, and 103 for TOC.* *Hardness varies across Massachusetts. The median value of hardness (as CaCO3) across all Massachusetts sites was 34 mg/L and most values (80 percent) were between 12 and 99 mg/L.*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Hardness was consistently high in the Housatonic and Hudson basins in western Massachusetts; most values were greater than 60 mg/L as CaCO3, with values greater than 120 mg/L as CaCO3 at about one-third of sites in the Housatonic basin. Relatively high values of hardness were also common in the Connecticut River Basin in west-central Massachusetts. Hardness was relatively low in the Millers, Nashua, Chicopee, Quinebaug, and French basins. *Average pH at most sites in Massachusetts ranged between 6.1 and 7.4, and the median value was 6.8. Regional patterns in pH were similar to those of hardness, in that relatively high values (greater than 6.8) were more consistently present in the western and west-central parts of the Commonwealth. Relatively low values (less than 6.8) were present in north-central and southeastern Massachusetts. Values in the northeast were mixed.* *DOC and TOC data were available for many fewer sites than hardness or pH, and most data were from sites in the eastern half of Massachusetts. Most values ranged between 3 and 12 mg/L, with median values of 6.0 mg/L for DOC and 6.6 mg/L for TOC. While we are pleased to see that the MLR takes into account pH, hardness and DOC, we believe that the upper limit for DOC does not reflect the range of DOC concentrations in Massachusetts. We request that the model be expanded to reflect the range of DOC concentrations observed in Massachusetts surface waters.*		
EPA-HQ-OW-2017-0260-0053 *(Abdul Alkhatib, Director, Massachusetts Water Works Association (MWWA))*	*I have reviewed EPA's proposal and believe that the changes proposed are beneficial and should move forward, however, we do offer the following comments for EPA's consideration before the new criteria is finalized:* ***1. Maximum DOC in Multiple Linear Regression Models****: The maximum dissolved organic carbon (DOC) limit for the new calculator is 5 mg/L. Some water bodies have significantly higher DOC and therefore potentially significantly higher toxicity limits. It would be an undue hardship for a permittee discharging to a water body with high DOC to be required to meet an unreasonably low Aluminum limit just because the scale of the model maxes out at 5 mg/L for DOC. The model should be expanded to account for higher DOC concentrations observed in New England waters.*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*Although the influences of hardness and dissolved organic carbon (DOC) are considered in the MLR, the effect ranges are truncated at concentrations of those two variables that are relatively low in relation to natural surface waters in many parts of the U.S. For hardness and DOC, values greater than 150 mg/L and 5 mg/L, respectively, would be expected to provide even greater limitations on aluminum bioavailability and result in higher but more accurate criteria values. EPA's 2016 Draft Technical Support Document, Recommended Estimates for Missing Water Quality Parameters for Application in EPA 's Biotic Ligand Model (EPA 820-R-15-106), indicates a considerable proportion of U. S. surface waters exceeds the 10th-percentile calcium concentration (60 mg/L) corresponding to 150 mg/L hardness (as $CaCO_3$); this distribution suggests many water bodies would be subject to overly stringent aluminum criteria if the criterion ceiling is established based on the assessed distribution as specified in the guidance document. A similar concern exists for DOC for which the conservative defaults (10th or 20th percentile), and thus many local water bodies, exceed 5 mg/L. While the proposed approach would likely yield protective criteria, valuable resources would be diverted to establish alternative site-specific criteria that would likely be at higher aluminum concentrations than those produced by default assumptions. Those resources could be better used where real problems exist, and areas where real problems exist may only be identified if the implemented criteria model is accurate across the wider range of chemistries that exist across the U.S.*		
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*As EPA observes, the MLR was developed from chronic toxicity studies conducted using test pH values that ranged between 6.0 and 8.1 (DeForest et al. 2017); however, EPA has chosen to apply the MLR to normalize toxicity data and, hence, generate aluminum criteria concentrations for waters outside this range both at low pH (i.e., between 5.0 and 6), and high (i.e., from 8.1 to 9.0) pH. While application of any model outside the test conditions used to derive or validate the model carries a high amount of scientific uncertainty, this is particularly the case for empirical models such as the MLR for which the equations can truly only be considered valid within the tested range. Whereas a mechanistic model such as the BLM may provide additional confidence when extrapolating outside the test conditions, extrapolating empirical models is much more problematic. In the draft criteria, EPA choses to not extrapolate use of the MLR for data normalization and criteria*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	calculations outside the tested hardness and DOC presented in DeForest et al. (2017) for this very reason-that the empirical model should not be used for conditions not considered in development of the model. API recommends that EPA treat pH the same as hardness and DOC with respect to use of the MLR, and not use the MLR for any calculations outside the water quality conditions used to develop the model. This would effectively "cap" MLR pH input values to being no less than 6.0, or no greater than 8.1. This is particularly important because EPA's application of the MLR in the draft aluminum criteria generates criteria concentrations that are significantly more stringent at pH values both above and below the tested range. Unless EPA can provide additional scientific confidence supporting the accuracy of criteria calculations outside the tested pH range, significant regulatory problems and costs could be incurred when little confidence exists that such problems are actually real.		
EPA-HQ-OW-2017-0260-0060 *(Katie Kistler, Environmental Manager of air Programs, AK Steel Corporation)*	*As explained through EPA's various support documents, the draft criteria were developed using multiple linear regression (MLR) models to predict the toxicity of aluminum as a function of pH, hardness, and dissolved organic carbon (DOC). That is, the criteria are intended to be implemented and calculated based upon site specific pH, hardness and DOC. However, the criteria calculations are bounded at a maximum of 150 mg/L hardness, a maximum of 5.0 mg/L DOC and pH range of 5.0 to 9.0 s.u. The upper bounds for hardness and DOC were chosen because they generally reflect the range of conditions encountered during the toxicity tests upon which the criteria are based. However, we believe that the upper bound hardness values does not reflect conditions in many receiving streams.* *EPA explained that hardness and DOC generally reduce aluminum toxicity. The hardness of receiving streams for the majority of AK Steel facilities substantially exceeds 150 mg/L, and may exceed 5.0 mg/L DOC. We have found no statements in the proposed language of the actual governing criteria restricting the applicability of the proposed criteria to these ranges, nor have we found any language in the actual proposed criteria cautioning the user against utilizing the criteria when site-specific conditions are outside of these ranges. In fact, the calculator developed by EPA to provide quick calculation of the criteria values allows the input of values outside of the hardness and DOC ranges, while limiting the values used in the calculation to a hardness of 150 mg/L and a*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	DOC concentration of 5 mg/L. *Many NPDES permit holders, in addition to AK Steel, discharge to receiving streams with hardness values of greater than 150 mg/L and DOC concentrations greater than 5.0 mg/L. Use of the proposed criteria for these receiving streams would therefore likely result in ambient criteria that would be substantially more stringent than necessary, or at least, the level of protection provided by the draft criteria would be uncertain.* *Given the prevalence of receiving streams outside of the criteria parameter bounds, AK Steel suggests that EPA withdraw postpone the proposed criteria and include a broader range of hardness and DOC values into the supporting toxicity tests, MLR models and the resulting criteria.*		
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	*UWAG agrees that the draft criteria should be based on the measurable water quality parameters that affect aluminum bioavailability and toxicity: pH, hardness, and DOC. And over the range of the underlying pH, hardness, and DOC data, the criteria derived using the proposed MLR models are appropriate. UWAG is concerned, however, over the use of the proposed MLR models to derive criteria for sites with parameters outside of the range of the underlying data. The scientific validity of doing so is questionable, and EPA has not provided information to support its validity. If the MLR models are to be used for sites with parameters outside of the range of the underlying data, the ability to extrapolate where appropriate outside of the range must be allowed. This is of particular concern for hardness.* *Based on an analysis of the toxicity tests used to develop the acute and chronic MLR models, EPA sets an upper (maximum) total hardness value of 150 mg/L as $CaCO_3$ for deriving aluminum criteria. Not allowing hardness values greater than 150 mg/L to be used for site-specific application of the criteria is problematic as, in some regions (e.g., the arid southwest), background (ambient) hardness values are considerably higher than 200 mg/L. In addition, many process wastewater discharges have hardness values much higher than 150 mg/L. Even as EPA acknowledges that such situations do occur, the Agency provides no room for extrapolation:* *"… the user can apply the model in areas with hardness values*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	greater than 150 mg/L and DOC of 5 mg/L, but the model output for these parameters will be limited at the bounds stated due to underlying data limitations." *Draft Criteria at xiii. While UWAG understands the technical reason for this, use of the MLR models as proposed to derive criteria for receiving streams and wastewaters with hardness values greater than 150 mg/L is scientifically questionable and inappropriately overprotective. EPA should allow for the ability to extrapolate to parameters outside of the range of the underlying toxicity data or limit the use of the MLR models to the underlying range.* *For example, the Arid West Water Quality Research Project (AWWQRP; 2006) updated the EPA 1988 aluminum aquatic life criteria (U.S. EPA, 1988) toxicity database and found a significant positive relationship with acute effect measurement and test media water hardness for species having the most toxicity endpoints reported (r^2 = 0.76; P < 0.03). The pooled slope of the acute endpoint and water hardness equation was 0.833. Using this slope and a CMC value of 1,289 µg/L total aluminum, the authors extrapolated protective acute criteria at water hardness values between 25 – 400 mg/L (Table 3-8 of report).* *UWAG also notes that, of the 119 acceptable acute tests listed in the draft criteria document (Appendix A), only 23 of these tests used a water hardness concentration greater than 100 mg/L. Optimally, EPA could conduct some additional toxicity tests at hardness values > 150 mg/L (e.g., within the range 150 – 400 mg/L) before the final criteria document is issued. Alternatively, the Agency could evaluate the acute effect-water hardness relationship and determine if the slope of tests having water hardness values > 100 mg/L differed from tests where lower hardness values were used. If the acute endpoint values in tests with water hardness values > 100 mg/L have a similar pattern relative to tests with lower hardness values, EPA should extend the regression slope for hardness values > 150 mg/L.*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	*EPA does extend the range for pH in the MLR models beyond the underlying data. Although the underlying data used to develop the MLR models are limited to a pH range of 6.0 to 8.1, EPA intends to apply the models to waters with a pH range of 5.0 to 9.0, albeit recognizing that criteria derived outside of the 6.0 to 8.1 range are more uncertain. Research has shown, however, that the MLR models are not inaccurate for pH from 8.1 to 9. (See Aluminum Industry comments.) As discussed above, UWAG supports extrapolation beyond the range of the underlying data,* ***but*** *only where it has been shown to be appropriate. It has not been shown to be appropriate for pH. For that reason, applicability of the MLR models should be limited to the pH range of the underlying data.*		
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*US EPA's handling of pH in the Draft Aluminum Criteria warrants re-evaluation. US EPA goes to considerable effort to develop aluminum criteria for waters that would be considered impaired for pH. The national recommended criteria for pH are limited to 6.5 to 9.0 due to the impact of low pH on aquatic life.* *Mount (1973) performed bioassays on the fathead minnow, Pimephales promelas, for a 13-month, one generation time period to determine chronic pH effects .... At the two lowest pH values (4.5 and 5.2) behavior was abnormal and the fish were deformed. At pH values less than 6.6, egg production and hatchability were reduced when compared with the control. It was concluded that* ***a pH of 6.6 was marginal for vital life functions.*** *Based on present evidence, a pH range of 6.5 to 9.0 appears to provide adequate protection for the life of freshwater fish and bottom dwelling invertebrates fish food organisms outside of this range,* ***fish suffer adverse physiological effects increasing in severity as the degree of deviation increases until lethal levels are reached.*** *(Quality Criteria for Water, 1986). Despite the well-documented effect of low pH on fish, the chronic aluminum database is based on largely studies that are outside the acceptable pH range. The studies for all four of the species utilized to calculate the FCV were conducted at pH<6.5. The database includes twenty-nine studies. More than half of the reported* EC_{20} *values were for studies conducted at pH<6.5. These studies had to be adjusted upward based on the data for C. dubia to pH 7.0.* *Two studies for C. dubia are included in the chronic database. The normalized chronic value for the study conducted at pH 7.70 was*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	3,569 µg/l based on a biomass endpoint. The normalized chronic value for the study conducted at pH 6.20 was 1,734 µg/l based on a survival endpoint. The study with a more sensitive endpoint resulted in a much higher chronic value when compared to the study conducted at a lower pH. The data suggests that the impact of pH as an independent stressor may affect the normalized values within the chronic database. *US EPA proposes to extend the pH range of the criteria (pH 5.0 to 9.0) well beyond the range of the empirical data used for model development (pH 6.0 to 8.1). On the converse, US EPA proposes to limit the range for DOC and hardness to precise boundaries of the empirical data for the MLR. This disparity is irrational. Moreover, the application of MLR outside the empirical data range yields questionable results. "The criteria values outside of the model input data range are more stringent than those within the model input range under the same hardness and DOC conditions and have greater uncertainty." (Draft Aluminum Criteria, p. 57). US EPA cannot corroborate the results of the MLR outside the empirical data range, and the effects at pH>8.1 are particularly suspect. While the WVCA believes the Draft Aluminum Criteria should be entirely redeveloped, the extension of the criteria beyond pH 6.0 to 8.1 is particularly egregious. The criteria for pH>8.1 should be "capped" similar to the method employed for hardness and DOC.* *US EPA cites recent studies which suggest that dissolved and suspended aluminum species (particularly insoluble hydroxides) are toxic to aquatic life. However, most of the toxicity studies were conducted at low pH to maximize the dissolved aluminum concentrations. Because of the important independent effect of pH, US EPA should obtain additional studies at circumneutral pH, at least for the four most sensitive species utilized for criteria calculations.*		
EPA-HQ-OW-2017-0260-0066 *(David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)*	*Maximum hardness and DOC values should not be capped at 150 mg/L and 5.0 mg/L, respectively. Natural background levels and stormwater can exceed these values.*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0066 (David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)	*The pH range over which the criteria apply should be limited to those values used to develop the MLR model and should not extrapolate beyond those values. Doing so introduces additional uncertainty.*		
EPA-HQ-OW-2017-0260-0069 (Julia Young, Water Quality Standards Coordinator, Kansas Department of Health and Environment (KDHE))	*3) The draft aluminum criteria has an upper bound for $CaCO_3$ of 150 mg/L and DOC of 5 mg/L. The majority of waterbodies throughout Kansas have $CaCO_3$ levels that exceed 150 mg/L and DOC levels that exceed 5 mg/L. It is understood that EPA bounded hardness and DOC at these limits because the available toxicity data did not extend beyond the maxima, however, EPA should consider expanding the bounds for both hardness and DOC to be more realistic to measured stream concentrations.*		
EPA-HQ-OW-2017-0260-0071 (Fredric P. Andes, Coordinator, Federal Water Quality Coalition (FWQC))	*The draft approach specifies a maximum hardness value of 150 mg/l, and a maximum DOC value of 5.0 mg/l. There are many waterbodies around the country that exceed those values due to natural levels. Also, many effluents - including stormwater discharges, cooling tower blowdown and utility water - will exceed those values. This situation is especially problematic when the receiving water is effluent-dominated during critical low-flow conditions. In all of these circumstances, application of the EPA maximum values will yield aluminum criteria that are unduly conservative, without any technical basis.*		
EPA-HQ-OW-2017-0260-0071 (Fredric P. Andes, Coordinator, Federal Water Quality Coalition (FWQC))	*EPA has expanded the pH range over which the criteria apply. The current EPA recommended criteria apply from 6.5 to 9.0, while the Draft Criteria extend that range down to pH of 5.0. The MLR models were developed using data with pH values no lower than 6.0. Moreover, there are questions about accuracy of the MLR models at pH above 8.1. We are concerned that extrapolation of the models to lower or higher pH values, beyond the scope of the scientific studies concerning the models, carries substantial uncertainty. EPA needs to provide a technical basis for the pH range used in the Draft Criteria.*		
EPA-HQ-OW-2017-0260-0073 (Curt Wells, Director of Regulatory Affairs, The Aluminum Association)	*The Association notes that the EPA capped model input hardness values to no higher than 150 mg/L and model input DOC values no higher than 5 mg/L based on the uncertainty of modeling predictability above those thresholds. The Association believes that a similar restricted approach to model input pH should also be pursued as detailed below. Moreover, the Association notes that the application of the MLR approach in establishing criteria for*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	waters with hardness levels above 150 mg/L, DOC over 5 mg/L, or pH lower than 6 or higher than 8.1 may exceed the appropriate use of the MLR, and result in overly stringent site-specific criteria. The Association thus urges the agency to further consider and explain the use of the MLR for such waters.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*According to EPA's proposal and information, the MLR is fully validated between pH 6 and 8.1, which captures the range of most waterbody chemistry. In the draft criteria, EPA extrapolates model performance up to waterbody pH 9 and based on this extrapolation, above pH 8.1 the model predicts increasing toxicity (i.e., lower criteria concentrations) up to pH 9.0. However, because the model is not validated above pH 8.1, there is significant uncertainty in the model's predictions when modeling in the range of pH 8.1 to pH 9.0. In fact, it may not even be mechanistically correct for aluminum concentrations above pH 8.1 to exhibit increasing toxicity as above pH 8.5 the speciation of dissolved aluminum changes considerably to more strongly favor the aluminate anion, with a likely concurrent reduction in toxicity due to its lesser binding potential on fish gill surfaces. Several recent studies referenced in the GEI review attached to these comments support that understanding. Given this significant uncertainty and the relative lack of acceptable acute and chronic toxicity data at higher pH's, the Association requests that EPA cap the model utilization to no higher than pH 8.1 unless/until a more thorough understanding of aluminum toxicity and model validation above pH 8.1 is available. Under this capping scenario, if a waterbody pH were found to be at a level greater than pH 8.1, a pH of 8.1 would be entered into the model and the resulting model output would be used to set the aluminum water quality criteria limit for that waterbody.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*According to EPA's proposal and information, the MLR is fully validated between pH 6 and 8.1 pH and the Nationally Recommended Water Quality Criteria for pH is in the range of pH 6.5 to pH 9. However, EPA extrapolates the MLR output down to waterbody pH 5 in the draft criteria. As more fully explained in the attached GEI comments, the Association believes that there continues to exist uncertainty in the MLR operation below its validated range although there is recognition that below pH 6 the dissolved ionic and monomeric forms of aluminum increase which generally leads to an increase in aquatic toxicity. However, the amount toxicity increases as pH decreases below 6 is not yet incorporated into the MLR, so the accuracy of the draft criteria*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	calculations in this range are unknown. Given this uncertainty in model performance below pH 6, the Association requests that the EPA set a floor of pH 6 for model usage with the recognition that this still provides an expansion of modeling applicability below the 1988 Nationally Recommended Water Quality Criteria lower level of pH 6.5. If EPA desires to use the MLR model down to pH 5, it must perform an MLR model validation down to that pH level and then expand the use of the model down to pH 5 using a data validated model rather than using an untested extrapolation.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*The multiple linear regression (MLR) models used as the basis for normalizing toxicity tests were developed using data only using pH values ranging from 6.0 to 8.1. Little justification for extrapolating the MLR outside this range is provided in Section 4.1. For example (see pages 56-57), EPA only points out that they are indeed extrapolating the MLR equations outside the tested pH range, and that criteria concentrations calculated outside this range (both low and high ends of the range) "are more stringent than those within the model input range under the same hardness and DOC conditions and have greater uncertainty." We suggest that at a minimum, EPA provides additional scientific justification for either the accuracy or protectiveness of these criteria, not just to state that they are subject to greater uncertainty. Most importantly, have any studies used to derive or validate the BLM provide at least some support to extrapolating the MLR equations outside this pH range? For example, gill complexation data used to develop the BLM provided by NIVA (Norway) provide information on effects on salmonids at pH values less than 6. We suggest the BLM be used to utilized to evaluate the accuracy of chronic criteria values at pH values below 6 and above 8 to see if there is consistency in responses with the MLR. Consistency would support further use of the MLR in these ranges, whereas any significant discrepancies may argue instead for a different approach than use of the MLR as currently proposed.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*And while the MLRs developed for aluminum show strong agreement between observed and predicted toxicity between pH 6 to 8.1, for an effects-based model like the MLR, extrapolation to test conditions beyond the original calibration parameters adds significant uncertainty. The use of the MLR to normalize data below pH 6.0 would not account for the change in the speciation of aluminum, nor the change in the mode of toxicity as pH decreases to more of an ionoregulatory mechanism. Therefore, the inclusion and MLR-normalization of toxicity data pH < 6 or > 8.1 is*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	questionable and would benefit from further justification by EPA.		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Considering this uncertainty below pH 6, we recommend that EPA provide either additional analysis to demonstrate that the MLR is valid below this range, or that EPA consider whether the aluminum criteria equations should be "capped" to use values no lower than pH 6. Such capping would be consistent with limits EPA is already recommending for hardness and DOC, and is a familiar approach similar to hardness equation caps often used for other metals (e.g., hardness no greater than 400 mg/L). Additional justification, particularly including comparisons to BLM criteria predictions at pH values below 6, would provide users of the model additional confidence that the MLR can accurately predict toxicity over this range of pH. Even if should instead EPA choose to simply "cap" the criteria to values no lower than pH 6, it would still expand the pH range over which the criteria are applied compared to the current criteria (i.e., no lower than pH 6.5).*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Furthermore, we believe it may not be mechanistically correct for aluminum criteria concentrations above pH 8.1 to be more stringent than concentrations derived at lower pH. While the effects of the aluminate anion ($Al(OH)_4^-$, which dominates aluminum speciation as pH increases beyond 8.5) on aluminum toxicity are poorly known, recent studies suggest that aluminate will not bind strongly to the fish gill and, hence, not contribute to aluminum toxicity to a significant degree. Examples include Poléo and Hytterød (2003), who concluded that the toxicity of the aluminate ion to Atlantic salmon was low at pH 9.5 (lower than the corresponding toxicity of cationic Al hydroxides) and Winter et al. (2005), who showed that aluminum accumulation on the gills of rainbow trout was lower at high pH (pH 10) owing to poor binding of the aluminate ion to the positively charged gill surface. Therefore, we suggest that EPA reconsider extrapolating the MLR above pH 8.1 because of the strong likelihood that Al is less toxic at this pH owing to the limited bioavailability of aluminate. Given the relative lack of acceptable acute or chronic aluminum toxicity data at the high end of this pH range, we recommend that EPA consider "capping" the pH values to which the MLR would apply to no greater than 8.1. Such a cap would set the MLR pH input value to 8.1 for any pH greater than 8.1 up to a pH of 9.0.*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0074 *(Timothy F. Moore, Risk Sciences, on behalf of Lake Elsinore and Canyon Lake Nutrient TMDL Task Force administered by the Lake Elsinore San Jacinto Watershed Authority (LESJWA))*	*Although the draft water quality criteria for aluminum includes a method to make adjustments for site-specific water chemistry factors, the proposed procedure "caps" these adjustments based on a maximum hardness of 150 mg/L and a maximum DOC concentration of 5 mg/L. EPA was reluctant to extrapolate beyond the range of input values used to develop the MLR model. However, such caps are artificially low compared to the hardness and DOC levels commonly measured in the arid southwest. For example, Canyon Lake has an average hardness of 300 mg/L and an average DOC concentration of 7 mg/L; both well above the range used to develop the MLR model.* *Using the highest ("capped") hardness and DOC values shown in Table K-8 of the draft criteria document, the maximum recommended chronic criteria (CCC) for aluminum in Canyon Lake is only 2,000 ug/L. However, prior to commencing the alum application program, the Task Force conducted a number of site-specific chronic toxicity tests using EPA's published Water Effects Ratio procedure to determine the "safe dose." [U.S. EPA. Interim Guidance on Determination and Use of Water-Effect Ratios for Metals. EPA-823-B-94-001 (Feb., 1994)] These tests confirmed that adding 40 mg/L of alum to samples of Canyon Lake water had <u>no adverse effect</u> on Fathead minnow survival or growth or Ceriodaphnia dubia survival or reproduction. [Since alum is comprised of 9% aluminum (by weight), 40 mg/L of alum is equivalent to 3,600 ug/L of aluminum.] Thus, in some cases, it appears that the "capped" MLR formula significantly underestimates the appropriate aluminum criteria.* *The draft criteria document acknowledges the need for additional data to accurately characterize the effects of higher hardness and DOC on the potential for aluminum toxicity. [Draft Criteria @ pg. 71] And, as noted above, the MLR model should also be expanded to include the binding properties of phosphorus. However, collecting the data needed to improve the MLR model will take many years and another 2 or 3 decades may go by before EPA elects to update the aluminum criteria again. Until then, there is a better alternative available.* *The Task Force recommends that EPA revise the aluminum criteria document to explicitly authorize and encourage the use of the existing Water Effects Ratio (WER) methods. The draft criteria*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	document makes no mention of the WER procedure. This omission may be misinterpreted to imply that it cannot or should not be used for aluminum. *Given the narrow range of hardness and DOC concentrations evaluated in the laboratory experiments that EPA considered when developing the MLR model, the WER procedure can be used to develop more appropriate site-specific standards or permit limits for aluminum when ambient water chemistry conditions fall outside the normal range of the MLR model. In addition, the WER procedure provides a method for evaluating how the numerous other site-specific factors that are not yet included in the MLR model (e.g. phosphorus binding) because EPA lacked sufficient data to accurately estimate the parameter coefficients.* *In sum, the proposed water quality criteria for aluminum does not make appropriate adjustments for hardness concentrations greater than 150 mg/L or for dissolved organic carbon (DOC) concentrations greater than 5 mg/L. In addition, the draft criteria makes no adjustment whatsoever for the mitigating effects of phosphorus on the potential for aluminum toxicity. Collectively, these limitations and omissions may make it far more difficult to authorize the use of alum in future NPDES permits unless EPA also endorses additional tools such as the WER procedure.*		
EPA-HQ-OW-2017-0260-0075 *(Steven A. Buffone, CHHM, QEP, GIT, Supervisor, Compliance and Regulatory Affairs, CONSOL Energy Inc.)*	*The 2017 draft criteria is more complex than the 1988 AWQC Criteria, with the addition of species, the derivation of data through normalization by application of a multiple linear regression model, and addressing the influence of numerous receiving water quality parameters including pH, DOC, and hardness.* *It is unclear how the criteria would be applied to discharges when pH, DOC, and hardness concentrations fall outside the limited thresholds defined by EPA's proposed regression model. For instance, in Pennsylvania, treatment to pH values above the model default limit of 9.0 s.u. is often required to facilitate manganese precipitation needed to comply with permitted effluent limits of 1 mg/L or less. In these cases, water treatment processes raise the pH to as high as 10.0 s.u.; however, the proposed EPA calculator does not account for pH levels above 9.0. Similarly, the hardness of permitted effluents is routinely above the maximum 150 mg/L as CaC03 limit included in the criteria calculator as a result of*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	conventional chemical treatment processes, which incorporate hydrated lime for neutralization and removal of metals. Certainly the states have much additional data available for these parameters that could be used to expand the limited thresholds included in EPA's model. • *CONSOL recommends that EPA clarify in the draft recommendation that in cases where pH is above the default limit of 9.0 that the draft criterion can still be utilized, as is the case for hardness and dissolved organic carbon (DOC) outside of the default limits of the criterion calculator.*		
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	*In the draft AWQC for aluminum, EPA states that aluminum solubility increases in lower temperatures and in the presence of complexing ligands (both inorganic and organic) (EPA 2017). Given the lower average temperatures naturally present in Alaskan surface water and potentially higher DOC concentrations, ADEC would like further clarification as to why EPA did not consider the effects of temperature when considering model development.*	Temperature was not considered because of the lack of experimental data that could be used to develop an additional parameter in the MLR.	No edits.
EPA-HQ-OW-2017-0260-0063 *(Kevin Oakes, Director of Wastewater, Borough of West Chester, Chester County, Pennsylvania)*	*The USEPA developed Water Quality Criteria (WQC) for aluminum in 1988 based on a limited number of toxicity studies, which was expressed as a fixed value for waters between 6.5 and 9.0 pH units, and did not account for other site-specific factors. These WQC were adopted by the Pennsylvania Department of Environmental Protection.* *On July 28, 2017, the EPA published in the Federal Register Request for Scientific Views: Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in freshwater. The EPA is seeking public comment on the proposed draft WQC for aluminum, which were updated to reflect the "latest science knowledge".* *Many studies have concluded that aluminum can accumulate on the surface of fish gill, leading to respiratory dysfunction, and possibly death.* *For years, researchers have been using bioavailability to measure the element in the environment that is available to enter living organisms, such as fish and other aquatic lives. The bioavailability of aluminum is dependent on the chemical properties of water that includes total hardness, pH and dissolved organic carbon (DOC), those compounds can affect the toxicity of aluminum by affecting the bioavailability of aluminum in the water to fish and other*		

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	aquatic lives. *However, despite the abundant scientific evidence and well established theories, it seems the effects of water temperature on aluminum toxicity was not considered by the USEPA in developing the new WQC for aluminum.* *In addition, we also like to recommend for the USEPA's consideration to develop seasonal WQC for aluminum for cold seasons when aluminum toxicity is lower.* *This proposal is similar to the USEPA's existing policies that apply less stringent limits for cold months (and more stringent seasonal NPDES limits for summer months) for ammonia and nutrients that include total nitrogen and total phosphorus, etc.*		
EPA-HQ-OW-2017-0260-0058 *(National Council for Air and Stream Improvement, Inc. (NCASI))*	*EPA should more rigorously evaluate and communicate MLR model prediction and criteria uncertainties throughout the document* *There are repeated references throughout the document (perhaps as a carryover from the DeForest et al. 2017 article) to model predictions that are within a "factor of two" for some percentage of the test data. This characterization is overused, and reflects an incomplete, potentially misleading and non-transparent approach to characterizing the performance of the MLR model. An example of the problem occurs in Panel A of Figure 4 in DeForest et al. (2017). This plot of two sets of predicted and observed values from two different MLR models shows that in both cases there is a high percentage of observed values that fall within a factor of two, yet the quality of the fit for one model is substantially better based on visual and other numeric/statistical measures. EPA should rely less on the "factor of two" characterization throughout the document, replacing it with additional, more rigorous and relevant information on predictive performance as outlined, for example, in EPA (2009) and McLaughlin (2015).* *Relatedly, in the evaluation of the C. dubia MLR model (page 29), the document states "No clear pattern was observed in the residuals over a wide range of water chemistry conditions or relative to single independent variables (DeForest et al. 2017)." The statement "No clear pattern..." is a broad generalization that*	The EPA was clear and transparent regarding the performance of the MLR model predictions in the draft aluminum criteria. Various performance metrics were described (i.e., R^2, AIC, BIC, visual performance, factor of two and residuals). While the factor of two is described in several places, this is not the only metric described (please refer to Section 2.7.1). The EPA disagrees that there is an upward trend in Figure S4, Panel F. Furthermore, the residual trends or lack of trends are the conclusions of the authors (DeForest et al. 2018a). The final aluminum criteria document is clear and transparent regarding the performance of the MLR model predictions. In the 2018 final aluminum criteria, the EPA used separate MLRs for fish and invertebrates to best capture the effects of water chemistry on toxicity for the taxa and differences in trends across water chemistry; Section 2.7.1 discusses the pH, hardness and DOC normalization approach the EPA took in the 2018 aluminum criteria document. Appendix L of the 2018 criteria document discusses the comparison of the MLR models used to normalize the toxicity data and compares the results of the fish and invertebrate and pooled taxa MLR approaches in detail. Thank you for finding the typographical error for the adapted Figures, these items were fixed.	Section 2.7.1 Figure 4 Figure 5 Figure 6 Figure 7 Appendix L

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	does not communicate the presence of some potentially important details in the actual fit of the models. In fact, there are some clear patterns, as shown in Fig. S4, panel F, where an upward trend exists, or in panels C, D, and E of the same figure (which is incorrectly labeled "D") which show decreasing variance with increasing DOC. A similar statement is made in regard to the P. Promelas model (page 32). "No clear pattern" in the model residuals indicates equal model prediction accuracy across all ranges of input variables. For both taxa, it is important to acknowledge that the data set available to evaluate the assertion of "no clear patterns" is relatively small. For example, in panel A of Figure 7, only two pH values are available to evaluate model fit for DOC of 2.7 mg/L and hardness of 122 mg/L, with no data at pH values above 7. With uncertainties as large as those shown by the plotted error bars, one must conclude that there is substantial opportunity for additional validation of this model, and EPA should be clear about this fact. The other models shown represent similar data-limited situations. *Additionally, it appears that the reference to Figure S7 in the title of the document's "Figure 7" is incorrect. Figure S7 is a 6-panel figure of genus sensitivity distributions that appears to not be related to Figure 7. Therefore, it is not clear how Figure 7 would be "adapted" from the referenced figure. A similar comment applies to Figure 6 as well.* *It appears that all of the available C. dubia and P. promelas data were used to create the statistical model, and that no cross-validation of the model was conducted. For example, a portion of the dataset could be excluded from that used for model development, and used instead for subsequent evaluation (see EPA 2009). If this is the case, the quality of the model fit may be overestimated. Furthermore, it is important to keep in mind that in the face of the data limitations for models of these two species, the draft criteria are based on the application of these models to other species where no data are available to evaluate the quality of the predictions (EPA acknowledges this on p.71).* *In Table 3 on page 42, SMAVs and GMAVs are presented without including counts or standard deviations of the data from which the averages are derived. This limits the transparency of the science used to derive water quality criteria. Furthermore, on page 68, the*	As stated in the 1985 Guidelines (pages 29 and 31), "For each species for which at least one acute value is available, the Species Mean Acute Value (SMAV) should be calculated..." and "For each genus for which one or more SMAVs are available, the Genus Mean Acute Value (GMAV) should be calculated..." Thus, one toxicity test result is sufficient to generate a SMAV/GMAV for the particular species/genus. The uncertainty associated with this approach is described in the document.	

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	document states "There are a number of cases in the acute database where only one acute test is used to determine the SMAV and subsequently the GMAV is based on the one acute test. In this situation, there is a level of uncertainty associated with the GMAV based on the one test result since it does not incorporate the range of values that would be available if multiple studies were available." Of course, it is also true that "there is a level of uncertainty" when more than one SMAV is available (see McLaughlin 2011). The wording used here seems to reflect inadequate attention on the part of EPA to the basic description of scientific uncertainties that exist in their recommended criteria, and the opportunities for additional scientific study to reduce them. EPA should revise the presentation of SMAVs and GMAVs in Table 3 to include information on the number of tests and the standard deviations of the toxicity data used to derive the draft aluminum criteria. *In conclusion, EPA's proposed criteria represent an improvement over the existing criteria, and should yield benefits in the effort to protect aquatic life from the adverse effects of aluminum. However, we encourage EPA to incorporate these comments in order to ensure that the strengths and limitations of the MLR approach are fully transparent, that model outcomes are implemented appropriately, and that continued important advances in the understanding of aluminum toxicity and modeling in support of aquatic life water quality criteria are encouraged.*		
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*The MLR is used twice - both as the basis of the data normalization and for the final criteria calculation. US EPA applied the MLR developed based on chronic toxicity to the acute data, with the large leap of faith assumption that the effect of water chemistry on bioavailability remains consistent across exposure durations and for lethal and sublethal endpoints. US EPA is attempting to quickly pass through a new approach without allowing States and affected stakeholders adequate time to fully critique the new approach. The data manipulation seriously affects the original toxicity determinations as well as calculation of the acute and chronic criteria based on pH, hardness, and DOC.* *To calculate the normalized values, one must assume that the MLR prepared from data for three species is applicable to all other species in the acute and chronic databases. One must make a greater leap of faith that the effects of pH, hardness, and DOC are*	The MLR models (i.e., the normalization equations described in Section 2.7.1) are used to normalize all of the freshwater acute and chronic toxicity data to common water chemistry conditions. Those normalized values are then ranked according to GMAV/GMCVs and criteria are calculated according to the method described in the 1985 Guidelines. The MLR models, therefore, are only used once for each criteria calculation, for normalizing the toxicity data). This procedure is repeated for all criteria calculations when the chosen water chemistry conditions are different (i.e., pH, total hardness and DOC). The criteria calculator, following the statistical approach outlined in the 1985 Guidelines, generates the criteria magnitude values for each set of water chemistry conditions. These values are also provided in summary tables in Appendix K of the 2018 criteria document. Please refer to Section 2.7.1 which elaborates on these normalization trends.	No edits.

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	consistent for both chronic and acute exposures. If all fish and invertebrates behaved the same way, we would have no diversity in our ecosystem. We know this is not accurate. We also know that certain fish are more sensitive than others, and the same holds true for invertebrates. *This is evident in the studies for the two most sensitive species in the chronic database. McKee reported that "significant reductions" in RNA content and DNA content in Atlantic salmon exposed to aluminum. (McKee, p. 3). Cleveland found no clear impact on RNA content or DNA content in the highest test exposures for brook trout.* *(Cleveland, Table 8). This is significant in the use of the MLR for P. promelas to normalize the chronic values for all fish prior to calculation of the FCV. The MLR assumes that all fish species will respond equally to aluminum and to the impacts of hardness, DOC, and pH. If the effect of aluminum on two sensitive fish within the salmonid family differs, it seems very unlikely that the sensitivity data for fathead minnows is applicable to all fish. Considering their diversity in behavior and function, it is even more unlikely that all invertebrates are represented by the data for C. dubia.* *Even for C. dubia, which were used to develop the MLR, the normalized results vary dramatically. All thirteen reported* EC_{20}*s for C. Dubia are for the reproduction endpoint, but the normalized chronic values range from 563.4 µg/l to 2,719 µg/l. More than half of the studies were conducted concurrently. (Gensemer 2017). If the MLR were appropriate, the normalized chronic values for C. dubia should be nearly identical. Before proceeding with the Draft Aluminum Criteria, US EPA must build a scientific demonstration that the MLRs are appropriate for normalizing the chronic data. It is beyond reason that the chronic MLR can be utilized to normalize the acute database. A separate MLR must be developed based on acute exposures.* *The MLR yields criteria that do not demonstrate the expected relationship to hardness and pH. "[B]oth C. dubia and P. promelas EC20s generally increase with each independent variable (DOC, pH, and hardness) regardless of the levels of the other two variables." (Deforest, p. 7). Therefore, one would expect*	The EPA discusses the use of the chronic toxicity data evaluating the effects of water chemistry to acute data in the 2018 final aluminum criteria document; this approach reflects the extrapolation of the effects of water chemistry across test durations, reflecting the same assumptions in principle accepted in the 2007 Copper BLM-based criteria. The approach is the most scientifically-defensible approach at this time, based on available data. RNA and DNA content are not used in the Aluminum criteria calculations; criteria are based on survival, growth and reproduction. The underlying basis of the 2018 final aluminum criteria is that water chemistry, specifically pH, hardness and DOC, affect bioavailability, and hence toxicity of aluminum, as reflected in the MLR normalizations underlying the criteria. As indicated in the 2018 final criteria document, increasing hardness generally increases criteria values, up to the hardness bounds of the model; in the 2018 final criteria document, at DOC=1.0 mg/l and pH 7.5, the calculated chronic criterion is 580 µg/l at a hardness of 25 mg/l, but is 660 mg/l at a hardness of 150 mg/l. EPA has clearly described the trends in criteria across water chemistry conditions, through graphical representations and criteria tables presented in the document. The commenter is directed to those. In general, increasing DOC and hardness tend to decrease bioavailability, resulting in increased protective criteria values, while low and high pHs tend to increase aluminum bioavailability, resulting in decreased protective criteria values. The 1988 national recommended aluminum chronic criteria was 87 µg/l, not 750 µg/l as the commenter incorrectly suggests. The EPA recommend 750 µg/l as the acute (one hour) criteria in 1988.	

Comment Number (Organization)	Public Comment on Topic 14: Regarding the MLR (multiple linear regression) models	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	the criteria to increase with each of these parameters. Based on the MLR, this does not occur. At DOC=1.0 mg/l and pH 7.5, the calculated chronic criterion is 900 µg/l at a hardness of 25 mg/l, but is 540 mg/l at a hardness of 150 mg/l. In other words, hardness is predicted to make aluminum more toxic at one of the most common pH values for natural waters. The calculated chronic criterion, which drives calculation of effluent limitations for NPDES permittees, is LOWER than the current US EPA recommended chronic criterion of 750 µg/l. The same downward trend exists for hardness at pH 7.0. Based on footnotes to the chart presented in Appendix K, Table K-4, the four most sensitive species at both pH 7.0 and 7.5 in all scenarios are fish and invertebrates. Why does the criterion decrease with hardness? *We are unable in the allotted time to re-create the MLR to investigate these surprising trends. Considering the species rankings in the chronic database, we would anticipate chronic criteria that would increase with pH, hardness, and DOC. This is not represented in Appendix K. In fact, the criteria are often inversely related to hardness and pH in the circumneutral to alkaline range. It appears that US EPA has spent so much time focusing on waters with impaired pH that no effort has been made to ensure the criteria are sensible for unimpaired waters.* *While we appreciate US EPA's efforts to improve the aluminum criteria through the development of the MLR, something has clearly gone wrong. We ask US EPA to reconsider the application of the MLR, as many healthy waters will be listed as impaired based on the calculated chronic criteria.*		

TOPIC 15: Comments regarding mussel toxicity data

Comment Number (Organization)	Public Comment on Topic 15: Regarding mussel toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*…there are indications from the record that Section 7 consultations would be beneficial here. For example, freshwater mollusks are the most imperiled group of organisms in United States with nearly two-thirds of species being identified as at risk-of extinction. Mussels are particularly sensitive to contamination from dissolved metals (Naimo 1995). Aluminum can be lethal to mollusks and is added to water by some water treatment facilities to kill the young larvae of invasive mussels (Mackie and Kilgour 1995).*	In response to concerns expressed by the USFWS and others that endangered freshwater mussel sensitive to aluminum needs to be taken into consideration in deriving the criteria, EPA identified studies by USGS (Wang et al. 2018) on freshwater mussels in the family Unionidae, a family of freshwater mussels found to be sensitive to some toxicants, These new data on aluminum toxicity to the fatmucket mussel (*Lampsilis siliquoidea*) are included in the final aluminum criteria. While the 96-hr LC_{50} juvenile test failed to elicit an acute 50% response at the highest concentration tested (6,302 µg/L total aluminum, or 29,492 µg/L when normalized), the 28-day biomass normalized SMCV ranked as the fourth most sensitive genus in the chronic dataset. The mussel's chronic value is greater than the most sensitive species, Atlantic salmon, and the freshwater criterion. Thus, the chronic criterion is expected to be protective of this and related mussel species. The fatmucket tested is not a threatened and/or endangered species, but the genus *Lampsilis* contains several listed species with a wide distribution across the United States. Additional testing on endangered mussel species, or closely related surrogates, would be useful to further examine the potential risk of aluminum exposures to endangered freshwater mussels. The studies the commenters noted were reviewed by the EPA and their information considered. Regarding Taskinen et al. (2011): The study was unused because the river water used for dilution water was not characterized. Huebner and Pynnonen (1992) data were deemed "unused" for criteria numeric calculations. *Anodonta anatina* and *Anodonta cygnea* are not native to North America, nor do they have naturally reproducing populations, but there are species of the *Anodonta* genus present in the United States. In the Huebner and Pynnonen (1992) data the glochidia 24.-hr EC_{50} conducted at pH 4.5 was approximately 18,000 µg/L.). Other data in these taxa by Pynnonen (1990) and Kadar et al.	No edits.
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*Several published studies indicate that native freshwater mollusks can be harmed by aluminum pollution. Huebner and Pynnonen (1992) found that exposure to increased aluminum decreased the viability of glochidia of the unionids Anodonta anatine and Anodonta cygnea. Malley et al. (1988) added aluminum sulfate to an experimental lake in Ontario to test the effects on adult mussels of the addition of aluminum and increasing acid levels in soft water, and found that Anodonta grandis grandis experienced blood and tissue ionic changes indicative of stress and exhibited aluminum accumulation in tissues. The authors concluded that in increasingly acidic conditions with high levels of aluminum, adult mussels could experience significant damage to their shells.*		
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*In the Ahtavanjoki River in Finland, Taskinen et al. (2011) reported that the endangered freshwater pearl mussel Margaritifera margaritifera experienced low reproductive success attributable to high concentrations of aluminum and iron accompanied with periods of low pH. Though the adult mussels appeared to be tolerant to periods of water quality variation and were able to produce glochidia, the early life cycle stages of mussels in the river were not successfully recruited into the population due to metal exposure. In laboratory experiments on mussels collected from the river, exposure to high but environmentally realistic levels of aluminum was toxic to free glochidia with most individuals dying within 72 hours. Importantly, the survival of control glochidia was significantly higher than that of any group of glochidia that were exposed to aluminum at any level. The authors also found that the survival of juvenile mussels was lower in groups exposed to aluminum than in the control group.*		

Comment Number (Organization)	Public Comment on Topic 15: Regarding mussel toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0039 *(Brett Hartl, Government Policy Director, Center for Biological Diversity)*	*Though aluminum is most readily uptaken by mollusks in acidic waters, Elangovan et al. (1997) found that the freshwater snail Lymnaea stagnalis accumulated significant levels of aluminum in neutral water in its soft tissues, gut, digestive gland and kidneys. Kadar et al. (2001) examined the effect of aluminum on the filtering behavior of the mussel Anodonta cygnea in neutral water at environmentally relevant concentrations and found that mussels closed their shells and avoided filtering at the higher concentration. Interestingly, the mussels exposed to the lower dose accumulated more aluminum in their tissues because they did not reduce filtering time in response to exposure as did the mussels exposed to the higher dose. They found that the mussels accumulated most of the aluminum in their kidneys and digestive glands. Their study provides evidence for the bioavailability and toxicity of aluminum to mussels at neutral pH.*	(2001) are discussed in the criteria document Effects Characterization section 5.4.3 (EPA also reviewed additional studies on mussels in developing the criteria document. Malley et al. (1988): Data deemed "Unused". *Anodonta grandis grandis* is native to North America, and the study did show blood and tissue ionic changes due to both pH and increased aluminum, but the pH and aluminum levels were variable during the exposure making it difficult to determine specific effect concentrations for pH and aluminum. Elangovan et al. (1997): Study deemed "Unused" (steady state not reached in bioaccumulation study). Kadar et al. (2001): Study was not used in criteria calculation but discussed in Effects characterization. (*Anodonta cygnea* is not a North American species).	
EPA-HQ-OW-2017-0260-0052 *(Heidi L. Dunn, President, Freshwater Mollusk Conservation Society (FMCS))*	*Mussels are particularly sensitive to contamination from dissolved metals (Naimo 1995). Aluminum can be lethal to mollusks and is added to water by some water treatment facilities to kill the young larvae of invasive mussels (Mackie and Kilgour 1995).* *Several published studies indicate that native freshwater mollusks can be harmed by aluminum pollution. Wang et al. (2017) recently reported acute and chronic toxicity of aluminum to juvenile Lampsilis siliquoidea. Based on chronic toxicity results, the mussel ranks as the 4th most sensitive species tested to date. Huebner and Pynnonen (1992) found that exposure to increased aluminum decreased the viability of glochidia of the unionids Anodonta anatina and Anodonta cygnea.* *Malley et al. (1988) added aluminum sulfate to an experimental lake in Ontario to test the effects on adult mussels of the addition of aluminum and increasing acid levels in soft water, and found that Anodonta grandis grandis experienced blood and tissue ionic changes indicative of stress and exhibited aluminum accumulation in tissues. The authors concluded that in increasingly acidic conditions with high levels of aluminum, adult mussels could experience significant damage to their shells.* *In the Ahtavanjoki River in Finland, Taskinen et al. (2011) reported that the endangered freshwater pearl mussel Margaritifera margaritifera experienced low reproductive success attributable to high concentrations of aluminum and iron*		

Comment Number (Organization)	Public Comment on Topic 15: Regarding mussel toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	accompanied with periods of low pH. Though the adult mussels appeared to be tolerant to periods of water quality variation and were able to produce glochidia, the early life cycle stages of mussels in the river were not successfully recruited into the population due to metal exposure. In laboratory experiments on mussels collected from the river, exposure to high but environmentally realistic levels of aluminum was toxic to free glochidia with most individuals dying within 72 hours. Importantly, the survival of control glochidia was significantly higher than that of any group of glochidia that were exposed to aluminum at any level. The authors also found that the survival of juvenile mussels was lower in groups exposed to aluminum than in the control group. *Though aluminum is most readily uptaken by mollusks in acidic waters, Elangovan et al. (1997) found that the freshwater snail Lymnaea stagnalis accumulated significant levels of aluminum in neutral water in its soft tissues, gut, digestive gland and kidneys. Kadar et al. (2001) examined the effect of aluminum on the filtering behavior of the mussel Anodonta cygnea in neutral water at environmentally relevant concentrations and found that mussels closed their shells and avoided filtering at the higher concentration. Interestingly, the mussels exposed to the lower dose accumulated more aluminum in their tissues because they did not reduce filtering time in response to exposure as did the mussels exposed to the higher dose. They found that the mussels accumulated most of the aluminum in their kidneys and digestive glands. Their study provides evidence for the bioavailability and toxicity of aluminum to mussels at neutral pH.* *In light of these studies demonstrating that aluminum can be harmful to mussels and snails in freshwaters, we urge you to implement criteria that are protective of all life stages mollusks. Inclusion of mussel chronic toxicity data in recalculation of the aluminum chronic criterion would help ensure that mollusks are protected.* *[Cited References]*		

Comment Number (Organization)	Public Comment on Topic 15: Regarding mussel toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0064 *(Scott G. Mandirola, Director, West Virginia Department of Environmental Protection (WVDEP))*	*Finally, it should be noted that commenters have not been given sufficient time to examine the freshwater mussel studies recently published and long-awaited for the development of this Draft Aluminum Criteria. It is difficult to comment on the Draft Aluminum Criteria when presented with research that is either still in peer-review or only very recently published.* *Again, WVDEP thanks EPA for the opportunity to comment on the Draft Aluminum Criterion, as it is quite important and particularly relevant to the state of West Virginia. WVDEP continually seeks to appropriately protect its aquatic environment, including protection from aluminum. WVDEP appreciates the monumental effort EPA has undergone for the last many years to develop this criterion. However, West Virginia would like to see additional consideration for the issues discussed herein to make this criterion a fully-protective nationally-recommended standard.*	The most recent study, Wang, N., C.D. Ivey, E.L. Brunson, D. Cleveland, C.G. Ingersoll, W.A. Stubblefield and A.S. Cardwell, was published in January of 2018. Acute and chronic toxicity of aluminum to a unionid mussel (*Lampsilis siliquoidea*) and an amphipod (*Hyalella azteca*) in water-only exposures. Environ. Toxicol. Chem. 37(1): 61-69.	No edits.
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	***Mussel Study*** *A study of the impacts of water column concentrations of aluminum on growth to juvenile mussels does not reliably reflect the exposure mechanism of immature mussels. Growth is more likely to be influenced by sediment and interstitial water (IW) concentrations of metals:* *"The development of the juvenile mussel sediment/IW test is important in determining site toxicity because it focuses on the environment that they inhabit. Yeager et al. (1994) found that* ***juvenile mussels pedal-feed in the substrate, exposed mostly to the sediments and IW, with little exposure to the water column****." (Simon, p. 13)(Emphasis added). In the unionid mussel study, significant differences occurred between the measured concentration of total aluminum in composite samples collected from the lower portion of the water column or at the bottoms of the test beakers compared to the upper portion of the water column. It is very likely that the reported toxicity was based on the concentrations in the lower portion of the water column, which by the end of the 28-day test were nearly double the concentration for the 1,200 µg/l exposure. The difference between the water column concentration and the bottom of the beaker in the lowest exposure concentration was even greater. Therefore, considering that IW is a more likely exposure mechanism, the aluminum concentrations from the bottom of the beaker are more representative of the actual exposure concentrations for the unionid mussels. If the*	The authors (Wang et al. 2016, 2018) follow ASTM protocol (ASTM E2455-06) to use the average concentration from the water column to calculate the EC_{20}s. Based on Figure 1, in the nominal 300 µg/L treatment, the water column value is 200 versus 400 in the bottom portion of the beaker. Note: the EC_{20} reported for biomass is 169 µg/L. The EPA agrees that exposure via sediment may be an important exposure pathway for juvenile and immature mussels. However, the aquatic life ambient water aluminum criteria use toxicity studies with exposure to aluminum in the water column.	No edits.

Comment Number (Organization)	Public Comment on Topic 15: Regarding mussel toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	concentration from the bottom of the beaker were used instead of the water column concentration, then it is likely that the fatmucket unionid mussel would no longer be among the four most sensitive species in the chronic database.		

TOPIC 16: Comments regarding plant toxicity data

Comment Number (Organization)	Public Comment on Topic 16: Regarding plant toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*Additionally, as part of the evaluation of impacts to marine systems, EPA identified that certain marine aquatic plants are sensitive to aluminum. The limited data included in the document shows that a marine grass species (Halophila stipulacea) that is not native to the United States, is impacted by levels of aluminum below the calculated freshwater criteria. Restoration of eel grass within marine waters is a concern to states in New England. As part of developing a marine water quality criteria for aluminum additional information is needed to determine if native marine plant species are also sensitive to aluminum, potentially disrupting eel grass restoration activities.*	Marine aluminum toxicity data are severely limited and therefore no estuarine/marine criteria can be recommended at this time.	No edits.
EPA-HQ-OW-2017-0260-0025 *(Peter T. Goodmann, Director, Kentucky Division of Water)*	*Finally, the toxicity data for green algae, for which the most data is available, appears to indicate that these plants are sensitive to aluminum. The Hornstrom et al. 1995 four-day toxicity studies (Appendix E of the supplemental materials), at pH 6.8 and hardness 14.9, indicate a LOEC of 200 µg/L and 100 µg/L for Monoraphidium dybowskii and Monoraphidium griffithii, respectively. Section 5.2 acknowledges that aluminum effect concentrations for freshwater algae ranged from 50 µg/L to 6,447 µg/L, with most values below 1,000 µg/L. Table 7 shows that the four most sensitive aquatic animal genera for chronic toxicity have GMCVs of 508.5 µg/L to 1,102 µg/L. This appears to indicate that green algae are at least sensitive, if not more sensitive, to aluminum toxicity as aquatic animals, and should be explained more thoroughly in Section 5.2 and 5.3.*	Thank you for your comment. Additional text has been added to the document. Plant data, and the associated water chemistry data necessary to normalize the plant toxicity test results for comparison with other taxa, were very limited. We reconsidered inclusion of the Gensemer at al 2017 algae data but did not include this plant toxicity tests because the tests were not of 96-hour duration. However, the information is included in Appendix H. Some aquatic plants have similar sensitivity to aquatic animals, thus the calculated criteria are expected to also protect these species.	Section 5.2
EPA-HQ-OW-2017-0260-0048 *(William Stubblefield, Professor, Environmental and Molecular Toxicology, Oregon State University on behalf of Aluminum Ecotoxicity Research Group)*	*The draft criteria document does not reflect the extant algae data reported in Gensemer et al. 2017 due to the 72-hr duration (Appendix H: pages H4-H15), which is shorter than the USEPA algae test duration of 96-hrs. We suggest EPA reconsider the inclusion of this dataset to Appendix E as the 72-hr test duration is the standard OECD methodology for chronic algae tests. Additionally, this dataset is extensive under varying pH, hardness, and DOC conditions; is used in the MLR equations in DeForest et al. (2017); and provides valuable insight into the toxicity of Al to freshwater algae.*		

Comment Number (Organization)	Public Comment on Topic 16: Regarding plant toxicity data	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	*Algae data from Gensemer et al. 2017 were not included in Appendix E because of the test duration.* *These studies tested the effects of pH, hardness, and DOC on algae growth. While these tests used a 72-hour test duration which is not consistent with the 96-hr requirement from the 1985 Guidelines, we suggest that 72-hr still represents a valid chronic exposure period given their rapid cell division rates and population level response that was measured. So while these data would not ultimately be used in criteria calculations, we suggest that EPA consider their inclusion in Appendix E since they represent a significant and valuable database regarding the effects of water quality on aluminum toxicity to algae.*		

TOPIC 17: Comment regarding Multi-Sector General Permit (MSGP)

Comment Number (Organization)	Public Comment on Topic 17: Regarding Multi-Sector General Permit (MSGP)	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	***Request to update the Multi-Sector General Permit (MSGP) with the new criteria*** *We request that EPA, in a separate regulatory action, update the MSGP with the new aluminum criteria. The MSGP currently uses the acute exposure criterion as a benchmark for aluminum discharged from industrial facilities. An update to the MSGP will allow states that have borrowed this benchmark to update their own benchmarks or action levels for industrial stormwater permits. This action is necessary for California to update the unnecessarily low action level in the statewide Industrial General Permit.*	Thank you for your comment.	No edits.

TOPIC 18: Comments regarding implementation issues

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	***Anti-backsliding:*** *Since the Clean Water Act contains anti-backsliding provisions, we wonder how EPA will handle cases where the new criteria results in a higher applicable criteria? It is our position that if new methodologies are available for calculating criteria, then permittees should be given the opportunity to apply the new methodology and their permit should be modified to adopt the new criteria, even if it results in criteria that may be considered move "favorable" than the old criteria. Permits must rely on the best available science and should not be bound by anti-backsliding provisions if new information is available.*	The intended protection goal of the 2018 final aluminum criteria remains the same as that of the 1988 criteria, protection of approximately 95% of genera in an ecosystem to support protection of an aquatic life designated use. The differences in the criteria values reflect an expanded toxicity database and an improved incorporation of the effects of water chemistry on bioavailability and toxicity in the 2018 final criteria. The EPA's criteria provide recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0053 *(Abdul Alkhatib, Director, Massachusetts Water Works Association (MWWA))*	***Anti-backsliding****: Since the Clean Water Act contains anti-backsliding provisions, the regulated community wonders how EPA will handle cases where the new criteria results in a higher applicable criteria? It is our association's position that if new methodologies are available for calculating criteria, then permittees should be given the opportunity to apply the new methodology and their permit should be modified to adopt the new criteria, even if it results in criteria that may be considered move "favorable" than the old criteria. Permits must rely on the best available science and should not be bound by anti-backsliding provisions if new information is available.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Implementation of the new criteria*** *Extensive new science developed since the existing 1988 guidelines were finalized has contributed to significant additional understanding of the chemical behavior of aluminum in water and this science is the foundation of EPA's proposed aluminum water quality criteria revisions. In order to fully recognize the value of that new science during both the development and implementation of the new criteria, it must be applied broadly to both new and existing permitted discharges of aluminum, even in cases where the application of better science may increase aluminum discharge limits when compared to existing limits. This is consistent with the concept of providing an exemption to the general prohibition against permit backsliding as found in CWA 402(o)(2)(B) for situations "where information is available which was not available at the time of permit issuance."*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*Several states already use the BLM and WER models for establishing site-specific standards. EPA should explicitly state that the BLM approach will be accepted in state standards provided the technical requirements of the BLM are appropriately met.*	The Aluminum AWQC are recommendations. States may choose other scientifically defensible methods to develop aluminum criteria. Current research on modeling indicates that the MLR and Biotic Ligand models have comparable performance in predicting aquatic toxicity for several chemicals, as long as both models are well-constructed and are supported with sufficient data. For example, Brix et al. (2017) concluded that the MLR and BLM models' performance for copper were comparable across a wide range of water chemistries and species (Environ. Sci. Technol., 2017, 51(9): 5182-5192).It should be noted that the MLR approach requires less data to implement and is more transparent to the public and users than the BLM. The MLR (and the BLM model described above) is reflective of a substantially larger toxicity database than a WER, which can depend greatly on the particular "snapshot" conditions during which the WER tests are conducted.	No edits.
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	***Implementation Issues*** ***1. Data collection for the inputs to the proposed aluminum criteria model*** *Like many recent national water quality criteria, the draft aluminum criteria will require implementation of permit specific criteria requiring new data collection efforts for the inputs to the model (i.e., pH, hardness and dissolved organic carbon). The analysis of the data may also pose significant implementation challenges based on DEC's experience with the biotic ligand model for copper. Implementation questions include: What will be considered sufficient data? How do we identify "critical conditions"? What percentiles should be entered as inputs or are instantaneous criteria to be implemented as variable permit limits? How do you calculate the criterion when little or no data is available for the inputs? Many waters in Alaska have not been monitored by any agency or permittee, so Alaska cannot rely on "available data" from independent sources. Such challenges may affect the timeline for adoption of this proposed criteria compared to traditional fixed or hardness-based toxics criteria. Because of the unresolved implementation issues, the timeframe for criteria adoption will have to be prioritized based state needs through the state Triennial Review process rather than national program*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). As noted in the criteria document, the EPA decided to use an empirical MLR approach in the aluminum criteria update rather than a BLM model due to: 1) the relative simplicity and transparency of the model, 2) the relative similarity to the available BLM model outputs, and 3) the decreased number of input data on water chemistry needed to derive criteria at different sites. The EPA is also separately compiling an updated national database of water chemistry conditions relevant to the MLR model: hardness, pH and DOC, and will make that data available to in the future to support states and stakeholders needs for model input data, when their own data are not available. The implementation documents that the EPA is developing are also intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	priorities.	provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	
EPA-HQ-OW-2017-0260-0036 (Barry N. Burnell, Water Quality Division Administrator, State of Idaho Department of Environmental Quality (DEQ))	*Many states, including Idaho, have very limited DOC data available. In the absence of sufficient DOC data, states will be unable to estimate protective aluminum criteria in waters where data are unavailable. EPA should provide states with options on how to implement these criteria when data for calculating the MLR are absent.*		
EPA-HQ-OW-2017-0260-0040 (Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))	*Our member states are also concerned they will not have the resources to determine aluminum limitations for areas that do not currently collect pH, DOC, and/or hardness data. With the ongoing reductions in funding, it will be difficult to implement additional monitoring programs to obtain this data. For areas where these parameters are tested in effluent rather than in the water body, it will be difficult to determine aluminum limitations. We urge EPA to address this concern with site specific data, not regional default data.*		
EPA-HQ-OW-2017-0260-0043 (Blake Beyea, Standards Unit Manager, Water Quality Control Division, Colorado Department of Public Health & Environment)	*The draft criteria require the user to input hardness, pH, and dissolved organic carbon (DOC) data to calculate protective criteria for a given site. The division was unable to determine what summary statistic for each parameter should be used when more than one data point is available for a given site. For instance, when data from multiple samples are available, should average hardness, pH, and DOC be used to calculate the criteria? Or, would a percentile, median, etc. be more appropriate? It would be helpful if EPA provided more clarity regarding implementation of the criteria to ensure criteria are calculated appropriately and protectively. If employing a summary statistic of input parameter data from multiple samples is not appropriate, how would EPA recommend implementing the resultant multiple final criteria values from multiple dates or sample sites?*		
EPA-HQ-OW-2017-0260-0043 (Blake Beyea, Standards Unit Manager, Water Quality Control Division, Colorado Department of Public Health & Environment)	*Does EPA have recommendations for minimum data requirements for the input parameters (i.e., hardness, pH, and DOC)? When possible, it is important to ensure the data used to calculate the criteria adequately capture any variability that may occur in a site's water chemistry.*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0058 *(National Council for Air and Stream Improvement, Inc. (NCASI))*	*EPA should explicitly recommend that MLR model input data be collected during the same sampling event(s) whenever possible.* *EPA proposes using MLR models to characterize the toxicity of total aluminum in freshwater aquatic systems as a function of pH, hardness, and dissolved organic carbon (DOC). These models are thought to capture the major independent variables affecting aluminum toxicity. It is recommended that EPA add language stating that it is most appropriate to use model input data obtained from sampling events in which the full suite of model inputs (hardness, pH, DOC) are collected simultaneously. These input parameters are spatially and temporally variable and do not necessarily vary in the same ways or to the same extent. For example, export of DOC from most aquatic systems is driven by hydrological processes (Schlesinger and Melack, 1981). It is commonly observed that DOC concentrations in streams peak during periods of high flow, which may typically occur during times of snow melt runoff in early spring, and then decline rapidly (Lewis and Grant 1979; Boyer et al. 1997; Sebestyen et al. 2008). The temporal pattern of DOC in snowmelt dominated systems is thought to be due to flushing of pore water from the upper soil horizons as the water table rises (Hornberger et al., 1994) and this flushing phenomenon often exhausts the terrestrial DOC pool for the year (Boyer et al., 1997). In contrast with DOC, hardness may peak in concentration during the late summer months to early fall months when steam flow is at its lowest. The USGS has comprehensive statistics on stream flow by state within their National Streamflow Statistics Program [https://water.usgs.gov/osw/programs/nss/NSSpubs_Rural.html#or], and that program's results consistently show the lowest stream flow during the months of July, August and September. The use of datasets comprised of temporally- and spatially-linked water quality endpoints helps ensure that consistent and reasonable combinations of data inputs are used for the MLR models.*		
EPA-HQ-OW-2017-0260-0060 *(Katie Kistler, Environmental Manager of air Programs, AK Steel Corporation)*	*<u>Method of Criteria Applicability</u>* *The parameters upon which the draft criteria are based (pH, hardness and DOC) are known to vary within the same receiving stream.* *Through our review of the draft criteria documents, we have not located guidance or proposed governing language regarding selection of these values when calculating the site specific criteria.*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Selection of the input parameter values will be of critical importance to NPDES permit holders; in many cases of equal importance to the criteria themselves. AK Steel also notes that while hardness concentrations and pH ranges of receiving streams are generally known, receiving stream concentrations of dissolved organic carbon (DOC) are much less available, making it difficult for NPDES permittees to fully evaluate the possible impact of the revised criteria at this time. *Based upon our review, it is unclear to AK Steel whether EPA intends for the draft criteria to be utilized with site-specific Water Effect Ratio studies. Such studies may account for higher site specific hardness and DOC concentrations than those upon which the criteria are based, or may account forms of 'particulate' aluminum that may be less bioavailable than forms involved with the toxicity tests upon which the criteria are based (e.g., aluminum bound by clays).* *Without such information, stakeholders are unable to provide proper feedback. AK Steel requests that EPA withdraw or postpose the proposed criteria until it coordinates with NPDES permitting authorities on developing guidance for criteria implementation and until any such information and guidance receives public review and comment.*		
EPA-HQ-OW-2017-0260-0069 (Julia Young, Water Quality Standards Coordinator, Kansas Department of Health and Environment (KDHE))	*4) Many states do not collect sample data for DOC, but do collect TOC data. When developing the implementation guidelines for the aluminum criterion it is recommended that EPA address the use of conversion factors.*		
EPA-HQ-OW-2017-0260-0020 (Jon Tack, Chief, Water Quality Bureau, Iowa Department of Natural Resources (DNR))	*4. Implementation* *The implementation procedure; the draft criteria need to address the implementation issue and clearly state that States have the discretion on how to implement the criteria. In the meantime, Iowa has questions on aluminum criteria implementation :* *(1) Are default criteria values (or input parameters) necessary? If the answer is yes, please explain why.* *(2) If default criteria values are necessary, do default criteria values (or input parameters) require EPA approval? If the answer*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	is yes, please explain why.		
EPA-HQ-OW-2017-0260-0014 (David Waterstreet, Manager, Watershed Protection Program, Water Quality Division, Wyoming Department of Environmental Quality (WDEQ/WQD))	*Finally, WDEQ/WQD requests that EPA develop implementation materials to accompany the criteria document. These materials will allow WDEQ/WQD to fully evaluate the proposed criteria and determine whether they are applicable to Wyoming surface waters.*		
EPA-HQ-OW-2017-0260-0021 & EPA-HQ-OW-2017-0260-0022 (Daryll Joyner, Administrator, Water Quality Standards Program, Florida Department of Environmental Protection (DEP))	*3. The documentation currently available for the proposed Al criteria includes no guidance concerning EPA's recommended implementation of the criteria. While EPA indicates implementation guidance will be provided after the criteria are finalized, States cannot conduct a complete evaluation of the proposed Al criteria without this information. Details concerning the planned implementation of a water quality criterion are a key factor in understanding the protectiveness of any water quality criterion, as well as the implications associated with adopting the criteria. Therefore, DEP recommends that EPA complete and provide their implementation guidance prior to finalizing the proposed criteria.*		
EPA-HQ-OW-2017-0260-0035 (Richard A. Hyde, P.E., Executive Director, Texas Commission on Environmental Quality (TCEQ))	*II. Lack of Guidance for Incorporation of the Criteria into Water Quality Standards Programs of the Clean Water Act.* ***A. The TCEQ recommends that EPA coordinate with the states and tribes to develop guidance, and should postpone the adoption of the criteria until all the necessary information, including the guidance, receives public review and comment.*** *The proposed criterion lacks guidance for the development of state water quality standards. Guidance is needed to assist states in the development of water quality standards. The following key areas need to be addressed in the guidance:* • *Data needed to run the MLR model, such as DOC, may be limited in state surface water quality datasets. EPA should provide guidance to reliably estimate needed parameters when data are limited. The EPA has developed similar draft guidance to estimate parameters for use in the biotic ligand model (BLM) for copper, which may also be appropriate for aluminum. EPA should clarify if methods described in Draft Technical Support Document: Recommended Estimates for Missing*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Water Quality Parameters for BLM are appropriate. • *States, including Texas, have relied-upon procedures such as WERs to modify EPA's 1988 aluminum criteria to ensure site-specific conditions affecting the bioavailability and toxicity of aluminum are incorporated. Guidance is needed to clarify how to address potentially-conflicting results between WERs and EPA's proposal, to assist states when considering the proposed criteria for adoption.* *Given the complex nature of the proposal and the significant change to the approach, the EPA should postpone finalizing the proposed criteria and coordinate with states and tribes regarding the expectations for inclusion in triennial reviews. Informational material should be provided for review prior to finalization of the criteria. Without this additional information, stakeholders cannot completely evaluate the proposal and will miss the opportunity to provide proper feedback.*		
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	***Implementation:*** *We understand that EPA does not have any implementation guidance available at this point, but we strongly suggest that the guidance be developed and ready upon finalization of the criteria.*		
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*In closing, API appreciates EPA's efforts to improve water quality criteria derivation methodology through better consideration of the effects of associated water chemistry on bioavailability. As our comments suggest, however, additional analyses are needed to improve the model to be more broadly applicable and avoid the likelihood of misspent effort in implementing criteria in the significant proportion of waters not represented by the model.*	The water chemistry bounds for the 2018 criteria were expanded, with details and rationale provided in the criteria document in Section 2.7.1.	Text, tables and MLR equations edited to incorporate new toxicity data throughout the document.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0068 (Rachel Gleason, Executive Director, Pennsylvania Coal Alliance (PCA))	*In reviewing the Draft Aluminum Criteria, it is unclear how the criteria would be applied to discharges that have a pH above the default limit of 9.0. This occurs in Pennsylvania due to the stringent treatment requirements for manganese at limit of 1 mg/L on discharges. The calculator does not account for pH levels above 9.0, however in order to precipitate manganese pH is often raised to as much as 10.0.* • *PCA recommends that US EPA clarify in the draft recommendation that in cases where pH is above the default limit of 9.0 that the draft criterion can still be utilized, as is the case for hardness and dissolved organic carbon (DOC) outside of the default limits of the criterion calculator.* • *We also feel that it's important that the states retain their primacy and be allowed to develop their own criteria or adopt the recommended criteria or portions of it as they feel is appropriate for their unique regional variations.*	Since the draft document was released, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. The bounds for pH of the toxicity tests underlying the models ranged from 6.0-8.7. The EPA is allowing the user to extrapolate beyond the pH values used to generate the MLR models. The criteria calculator can be used to address all waters within a pH range of 5.0 to 10.5. For additional discussion see Section 4 in the 2018 criteria document. States can adopt the recommended criteria of other scientifically-defensible criteria. The 2018 aluminum criteria recommendations do enable inclusion of unique regional variations in water chemistry.	No edits.
EPA-HQ-OW-2017-0260-0045 (Lee Lemke, Executive Vice President, Georgia Mining Association (GMA))	*A unique characteristic of Georgia's mining industry is the significant presence of the kaolin mining sector. Given the chemical composition of kaolinite, implementation of the Draft Criteria will impose a serious and unnecessary regulatory burden on the kaolin mining industry in Georgia. The cost to comply with an aluminum standard based on the Draft Criteria in its current form will lead to significant economic hardships for kaolin mining companies with real potential for job loss and associated adverse effects for companies providing support to this industry.* *[Figure 1]* *KAOLINITE* *Kaolinite is a widespread aluminosilicate clay mineral in soils. Kaolinite is particularly prevalent in warm, moist climates, such as the southeastern United States (Figure 1). Kaolinite (Al2Si2O5(OH4)) is composed of a tetrahedral and an octahedral sheet, which constitute a single layer in a triclinic unit cell. This structure renders kaolinite particularly resistant to weathering and transformation, and provides relatively few adsorption sites compared to many other clay minerals (Birkeland 1999).* *"When two kaolinite sheets are superposed, the O- present on the upper surface and the H+ of the lower surface develop a strong hydrogen bond OH between them, conferring with the van der*	The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum.	Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Waals bonds a great stability to the stack of sheets against the action of water." (El Brahmi and Zoukaghe 2016, p.69-70). *Kaolinite forms as a result of specific weathering reactions (hydrolysis of feldspathic minerals) in the seasonal tropics and subtropics. The resulting kaolinite mineral is an end product of weathering in all but circumequatorial climates (Hugget 2011), and is considered to be insoluble in water and otherwise inert (Dixon 1977; Bloom 2004). Kaolinite is thus non-toxic and will not become toxic at pH ranges of natural waters. Furthermore, among clay minerals, kaolinite has a very low cation exchange capacity (Birkeland 1999), and is therefore not a carrier of bioavailable aluminum species.*	In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters.	
EPA-HQ-OW-2017-0260-0045 *(Lee Lemke, Executive Vice President, Georgia Mining Association (GMA))*	*The Draft Criteria relies on many experimental studies evaluating the potential toxicity of aluminum using highly soluble metal salts (e.g., aluminum chloride, aluminum sulfate, and aluminum nitrate). These forms of aluminum are experimentally efficient to use, as they fully dissolve in water. However, these forms are not representative of many naturally-occurring forms of aluminum. The aluminum in these highly soluble compounds becomes biologically available on very short time frames (seconds to hours). In contrast, the average kaolinite particle (or crystal) is insoluble and accordingly will remain stable in the environment at pH = 5.0 for 6,000,000+ years (Bloom 2004). Thus, the experimental design of the referenced studies, and the conclusions drawn from those studies, are completely inapplicable to aluminosilicate minerals, including kaolinite, whose aluminum atoms are physically bound within the mineral lattice.* ***Soluble aluminum salts are therefore not appropriate proxies for kaolinite*** *and other soil minerals that are insoluble and nontoxic.* *The availability of aluminum species is indicated by a chemical concept known as the solubility product constant (K_{sp}), where the more readily soluble the material is in water, the higher the K_{sp}. (Note: K_{sp} values of less than 10^{-4} are considered to be insoluble (Bailar et al., 1978).) The enormous difference in the availability of the aluminum in the salts used in the EPA's experiments and the aluminum in kaolinite is illustrated by the fact that the K_{sp} values differ by up to forty orders of magnitude (Table 1).*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0044 (Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)	*This guidance, from its title identifies the application of the aluminum standard to be applicable only under ambient conditions.* ***The State of New Mexico would like guidance for criteria which would be applicable under non-ambient conditions****.*	The EPA's aquatic life criteria provide recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). States may use these criteria to assess ambient waters and in development of permit limits for discharges. The intended protection goal of the 2018 final aluminum criteria remains the same as that of the 1988 criteria, protection of approximately 95% of genera in an ecosystem to support protection of an aquatic life designated use. The differences in the criteria values reflect an expanded toxicity database and an improved incorporation of the effects of water chemistry on bioavailability and toxicity in the 2018 final criteria. The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0038 (Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)	*As we reviewed the proposed criteria, the following question was raised and should be addressed in Guidance: How are the criteria translated into a discharge limit for a permit? Water quality can change seasonally and therefore permittees wonder which samples will be used for establishing the discharge limits.*		
EPA-HQ-OW-2017-0260-0040 (Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))	*Some of our states see the potential for deriving National Pollutant Discharge Elimination System (NPDES) permit limits for aluminum from multiple linear regression analysis. We request that EPA provide detailed guidance on the data collection necessary to support reasonable potential analysis for NPDES permits and the site-specific adjustment of aluminum criteria. Further, how will anti-backsliding requirements be applied to the development of site specific criteria requests where data could allow for an increase in aluminum concentrations? Further guidance from EPA is requested to address such situations.*		
EPA-HQ-OW-2017-0260-0051 (Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))	*Implementation: NPDES Permits – Data Collection & Anti-backsliding - National Pollutant Discharge Elimination System (NPDES) permits for wastewater treatment facilities (WWTFs) and Drinking Water Treatment Facilities (DWTFs) may include effluent limits for total aluminum. EPA Region 1, who is the lead permitting authority in Massachusetts because we do not have NPDES delegation, is including aluminum limits at some WWTFs and DWTFs. Many of these facilities are likely to need costly retrofits and/or alternative treatment coagulants in order to meet those limits.* *To develop permit limits, permit writers conduct an analysis to determine if there is a "reasonable potential" that water quality standards will be violated. Permit limits must comply with existing water quality standards and the determination of the final limits must also include an "anti-backsliding" analysis to maintain the integrity of receiving waters. Anti-backsliding statutory and regulatory provisions prohibit restrictions on effluent discharge in an existing permit that are less stringent than the restrictions established in previous permits at the same facility, except under*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	specific circumstances.		
EPA-HQ-OW-2017-0260-0051 *(Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))*	*6. Once finalized, the aluminum MLR could also be used to conduct reasonable potential analysis and, if necessary, derive NPDES permit limits for aluminum. If a permit holder wishes to pursue the development of site-specific criteria using the aluminum MLR, data collection will be necessary. The ideal time to begin data collection is two to three years before the permit expires. Massachusetts intends to work with the regulated community to conduct reasonable potential analyses and, if necessary, collect data site-specifically to support adjusting the aluminum criteria to local conditions in the Commonwealth. We request that EPA provide explicit guidance on the data collection necessary to support reasonable potential analysis for NPDES permits and the site-specific adjustment of aluminum criteria. In addition, MassDEP requests guidance on how the anti-backsliding provisions will be implemented in cases where the new criteria model results in a higher applicable aluminum criteria.*		
EPA-HQ-OW-2017-0260-0053 *(Abdul Alkhatib, Director, Massachusetts Water Works Association (MWWA))*	***Implementation**: I understand that EPA does not have any implementation guidance available at this point, but we strongly suggest that the guidance be developed and ready upon finalization of the criteria.* *EPA should provide updated guidance for performing calculations and/or studies to determine higher regulatory Aluminum toxicity limits when water bodies are not within the calculator's limits for pH, hardness, and DOC.* *As our organization reviewed the proposed criteria, the following question was raised and should be addressed in Guidance: How are the criteria translated into a discharge limit for a permit? Water quality can change seasonally and therefore permittees wonder which samples will be used for establishing the discharge limits.* *It is important for EPA to define the "site" for sampling the water quality parameters that are input into the model. I understand that the samples for the water quality parameters (hardness, TOC, DOC, pH) should be done in the receiving waters and not from the discharge, but EPA should make that explicit in the final document.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment. The water chemistry bounds for the 2018 criteria were expanded, with details and rationale provided in Section 4.0 in the criteria document.	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0066 *(David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)*	*States should be allowed to use the dissolved form of acid-soluble aluminum with site-specific dissolved-particulate studies to determine a particular facility's permit limits.*	The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. If a state used a dissolved form of aluminum with site specific dissolved particulate studies for permit limits, it would not address the colloidal and precipitated forms of aluminum that are bioavailable to organisms. In addition, it is unclear how the method for using the aluminum criteria calculator would need to change to address this approach. In the 2018 Final aluminum criteria document, the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E.	No edits.
EPA-HQ-OW-2017-0260-0043 *(Blake Beyea, Standards Unit Manager, Water Quality Control Division, Colorado Department of Public Health & Environment)*	*The division recommends including a discussion about seasonal variability in the next version of the criteria document. For example, during high-flow, snowmelt conditions, DOC often increases while hardness decreases; these types of changes in water chemistry could result in the need for more stringent criteria during part of the year to ensure protection of aquatic life. While the division understands that this type of variability would likely need to be addressed on a site-specific basis, it is important to acknowledge that seasonal conditions may cause changes in water chemistry and potentially the bioavailability of aluminum to aquatic life.*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters. The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. Concerns about different conditions in regard to flow and changes in water chemistry due to seasonal variation will be discussed. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	
EPA-HQ-OW-2017-0260-0023 *(Stan Dempsey Jr., CMA President, Colorado Mining Association (CMA))*	*EPA should provide some guidance as to whether the MLR can be modified to be state, region, or species specific. When States implement these criteria recommendations in the water quality standards, States often begin with the final EPA criteria and then modify it to be more applicable to the aquatic species within the state waters. States should be given some guidance as to whether modification of the MLR would follow the same approach.*	Thank you for your suggestion. Please work with your local EPA Region and the EPA Headquarters' staff to develop site-specific criteria values (i.e., add/delete species/genera), if appropriate.	No edits.
EPA-HQ-OW-2017-0260-0029 *(Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))*	*A review of the criteria for various water chemistry conditions (Appendix K of the Draft), includes summaries of ranking for the four most sensitive genera, used to derive total aluminum acute and chronic criteria values. The CMCs and CCCs presented in Appendix K show that within the pH range of 6.0 – 8.0, criteria values are very dependent upon the presence of salmonids (Salvo, Salvelinus, Oncorhynchus). This suggests that either there should be separate cold water and warm water criteria for aluminum, or criteria should be reevaluated for waters that do not support salmonids.*	Species included in a sensitivity distribution for criteria are considered surrogates for other taxonomically-related species, due to genetic conservation of important toxicity response traits in species. Fish in the family Salmonidae, such as the Atlantic salmon, include many recreationally and commercially important species, as well as endangered species, which are have broad relevance across the U.S. Further, regarding comments from the *Minnesota Environmental Science and Economic Review Board* regarding the utility of the aluminum criteria due to the inclusion of salmonids in the sensitive genera, the Minnesota Department of Natural Resources' website (https://www.dnr.state.mn.us/fishing/trout_streams/trout_spe	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0032 *(Phillip M. Gonet, President, Illinois Coal Association (ICA))*	***Selected Species*** *The Draft Criteria states that the most sensitive species in the MLR model was the Atlantic salmon. EPA should not be using a species with such limited range to define nationwide criteria. Furthermore, EPA should provide guidance to states that explains how the criteria can be modified to be state-specific, such that each state can determine what species list is most appropriate for their waterways.*	cies.html) specifies that three species of trout are found in southeast Minnesota, brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), thus three salmonid genera are present in southeastern MN. The DNR site also notes that trout lakes are found primarily in northeastern MN and are extremely popular with recreational fishers (https://www.dnr.state.mn.us/fishing/trout_lakes/index.html), and that lake trout (Salvelinus namaycush) and rainbow trout are also found in Lake Superior. Thus, inclusion of salmonids is broadly useful for aluminum criteria development relevant to at least a number of areas in Minnesota. Regarding the utility of including salmonids in the sensitivity distribution for aluminum in Illinois, the IL DNR notes that brook trout live in streams in the northern one-fourth of the state and in Lake Michigan, and that both brown trout and rainbow trout are stocked in IL in Lake Michigan and other lakes and streams for recreational fishing. (https://www.dnr.illinois.gov/education/Pages/WAFSalmon.aspx) Regarding the utility of including salmonids in the sensitivity distribution for aluminum in Indiana, the Indiana DNR, notes that brook, brown, lake and rainbow trout are found in the northern area of the state near the Great Lakes region, with brook trout and lake trout native to the Great Lakes area; rainbow and brown trout introduced to Indiana. (https://www.in.gov/dnr/fishwild/files/fw-trout.pdf) Due to the complexity of the final 2018 aluminum criteria, please work with your local EPA Region and the EPA Headquarters' staff to develop site-specific criteria values, including species recalculation procedures, as appropriate.	
EPA-HQ-OW-2017-0260-0034 *(James Boswell, Senior Manager, Environmental, Peabody Energy)*	***Applicability of Species****: The draft criteria document notes that the fish genus Salmo, represented by the Atlantic salmon, was the most sensitive genus. EPA should include some discussion of how this species impacts the resulting criteria and what potential options for modification there are for states where a recalculation procedure may be appropriate. States often use a recalculation to modify criteria based on species present within a state or region. Peabody expects that aluminum will be no different than other metals, so EPA should provide some discussion of the options states have for modifying this criteria to a state-specific value or species' subset value. For example, many of Peabody's western operations are located in areas with limited aquatic life and no or very few fish as a result of limited streamflow. Such areas would be a prime target for application of the standard based on a subset of species. Basing a standard on species that are absent in a region will again result in unnecessary costs to states and industry studying aluminum levels and implementing reduction measures when it is not necessary to protect the aquatic life that is present.* *[TABLE 1]*		
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*It is also not clear how multiple samples from a site should be used in the Aluminum Criteria Calculator. For sites with multiple input datasets (i.e., pH, hardness, and DOC collected at different times), would the approach for the calculator be similar to the approach for the Biotic Ligand Model (BLM) for copper? The criteria document should also include a discussion regarding the applicable geographic extent of any site-specific water quality criteria, particularly in light of downstream protection provisions*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	within Water Quality Standards. For example, it would be necessary to evaluate changes in water quality throughout a watershed to determine if there is a potential for aluminum to become more bioavailable based on water chemistry changes further downstream in the watershed.	implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	
EPA-HQ-OW-2017-0260-0042 *(Bruce A. Stevens, President, Indiana Coal Council, Inc. (ICC))*	*When States implement the Federal criteria recommendations into State water quality standards, they are typically allowed to modify the criteria to be specific to the species that inhabit the state. EPA should include some discussion of how this can be accomplished with the MLR model. This is particularly true because the most sensitive species in the MLR model is the Atlantic salmon, which is extremely limited in its range. States should be able to modify the MLR to account for a more representative species list and EPA should provide some discussion of this process.*	Species included in a sensitivity distribution for criteria are considered surrogates for other taxonomically-related species, due to genetic conservation of important toxicity response traits in species. Fish in the family Salmonidae, such as the Atlantic salmon, include many recreationally and commercially important species, as well as endangered species, which are have broad relevance across the U.S. Please work with your local EPA Region and the EPA Headquarters' staff to develop site-specific criteria values, if appropriate.	No edits.
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*8. The District understands that the EPA's 304(a) water quality criteria are merely "guidance" and impose no direct binding obligation on dischargers until states act to adopt these criteria as water quality standards. [DAC @ pg. iv] However, states are required to review and update their water quality standards every three years and, where a 304(a) criteria has been developed, are expected to adopt a standard based on that criteria or using some other scientifically-defensible approach. Based on years of prior precedent, it is evident that few states have the resources or expertise to develop their own water quality criteria and, instead, elect to rely on the EPA's 304(a) guidance to establish new water quality standards for most pollutants. In fact, more recently some states simply use the EPA's 304(a) guidance to "translate" existing narrative water quality standards when preparing triannual 303(d) water quality assessment or deriving numeric effluent limits. For this reason the District is deeply concerned that the proposed criteria for Total Aluminum will be applied without regard for the many nuanced "uncertainties" the EPA calls out in the draft document. [DAC @ pg. 69] This is made more likely by the EP A's decision to discount these uncertainties by describing its approach as "conservative." Such a claim leaves a false impression that the "conservative" approach somehow addresses the residual scientific uncertainties, when it does no such thing.*	Thank you for your comment. EPA is confident that the criteria developed and externally peer reviewed represent the latest science and are protective of aquatic life designated uses. There are uncertainties in all scientific analyses and for transparency EPA included a discussion of uncertainties in data available and in extrapolation of criteria beyond the bounds of the empirical model data. However, the overall database for aluminum in freshwater is robust and the criteria developed represent the latest science.	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0049 (Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)	*(K) The EPA should consider developing a separate water quality criteria recommendation for warm water and cold water ecosystems. Past experience has shown that stakeholders throughout the country must pay consultants to perform the exact same recalculation procedure to adjust for highly sensitive cold water species (like trout and salmon) that are not present in warm water streams. It would save considerable cost if the EPA were to do this calculation itself and publish the results as an acceptable warm water alternative so that state authorities could consider this difference from the outset rather than having to undertake the burdensome rule-making procedure required to adopt site-specific standards on case-by-case basis.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment. Species included in a sensitivity distribution for criteria are considered surrogates for other taxonomically-related species, due to genetic conservation of important toxicity response traits in species. Fish in the family Salmonidae, such as the Atlantic salmon, include many recreationally and commercially important species, as well as endangered species, which are have broad relevance across the U.S. Please work with your local EPA Region and the EPA Headquarters' staff to develop site-specific criteria values, if appropriate.	No edits.
EPA-HQ-OW-2017-0260-0050 (J. Tyler White, President, Kentucky Coal Association (KCA))	*The Draft Criteria uses the Atlantic salmon as the most sensitive species in the Multiple Linear Regression ("MLR") model. This species, which has a limited range and does not exist in many of the states that will be potentially impacted by the criteria, is not appropriate for use in establishing national recommended criteria.*		
EPA-HQ-OW-2017-0260-0040 (Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))	*When considering the input values used for the derivation of the acute water quality criterion for aluminum and the 1-hour in three year duration and frequency for the criterion, there may need to be a consideration of the impacts of storm water on receiving water chemistry. In water bodies that are significantly affected by stormwater, water chemistry may change for one or more hours as a result of storm events. These changes may need to be considered as part of the evaluation of the appropriate values for pH, hardness, and DOC to be used in criteria derivation.*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*Given the high concentration of aluminum in natural soils and the high concentration of soil particles entrained in storm water and stream flows during periods of wet weather, it is absolutely certain that very high concentrations of Total Aluminum will be reported for samples collected under such conditions. This data will be used to conclude that a huge number of lakes and rivers are "impaired" by excessive aluminum and should be added to the state 303(d) lists. Recent experience indicates that this will most likely occur by claiming that the measured concentrations of Total Aluminum violate the state's narrative toxicity standard. [See, for example, Line of Evidence #8321 for Decision ID #65478 in California's 2014-2016 Integrated 303(d) Report where EPA's 1988 aluminum criteria was used to translate a narrative toxicity standard.] These listings will trigger a follow-up requirement to develop TMDLs with Load and Wasteload Allocations which will also be translated directly from the EPA's 304(a) criteria. Therefore, it is incumbent on the EPA to make certain that the proposed criteria for Total Aluminum include detailed guidance to ensure that it is interpreted and implemented in a manner that is consistent with the numerous caveats and assumptions scattered throughout the draft document. To that end, the District offers the following recommendations:*	The EPA is aware, and has noted in the 2018 aluminum criteria document, that under natural conditions not all forms of aluminum would be biologically available to aquatic species (e.g., clay-bound aluminum). The EPA has also noted in its 2018 final aluminum criteria document that the EPA Methods 200.7 and 200.8 are the only currently approved methods for measuring aluminum in natural waters and wastes for NPDES permits. The EPA further notes in the 2018 criteria document that research on new analytical methods is ongoing to address concerns with including aluminum bound to particulate matter (i.e., clay) in the total recoverable aluminum concentrations (OSU 2018c). environment.	
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*(F) The final criteria should recommend that the Criteria Maximum Concentration (CMC), not the Criteria Continuous Concentration (CCC), are more appropriate for evaluating the true potential for instream toxicity to occur during wet weather events. In addition, the EPA should warn that the 1-hour exposure assumption normally used for priority pollutant metals might not be appropriate for non-conventional pollutants such as aluminum.*	The EPA determined that the one-hour average assumption for the CMC is appropriate. This position is supported by the 1985 Guidelines. More specifically, page 5 of the 1985 Guidelines states that "*For the CMC the averaging period should again be substantially less than the lengths of the tests it is based on, i.e., substantially less than 48 to 96 hours. One hour is probably an appropriate averaging period because high concentrations of some materials can cause death in one to three hours. Even when organisms do not die within the first hour or so, it is not known how many might have died due to delayed effects of this short of an exposure. Thus, it is not appropriate to allow concentrations above the CMC to exist for as long as one hour. The durations of the averaging periods in national criteria have been made short enough to restrict allowable fluctuations in the concentration of the pollutant in the receiving water and to restrict the length of time that the concentration in the receiving water can be continuously above a criterion concentration*." Page 6 of the 1985 Guidelines further states that "*the one-hour average should never exceed the CMC.*" The duration of a criterion is based on scientific considerations of toxicological activity;	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		status on the existing priority pollutant list is not considered.	
EPA-HQ-OW-2017-0260-0063 *(Kevin Oakes, Director of Wastewater, Borough of West Chester, Chester County, Pennsylvania)*	*B. The Borough of West Chester believes seasonal water quality criteria for aluminum should be developed to reflect the water environment in the receiving stream in cold seasons.* *In general, the period between November 1st and March 31st is considered as "non-or low growth season" for aquatic lives. In fact, both USEPA and PaDEP have traditionally applied higher seasonal NPDES limits for ammonia, total nitrogen (TN) and total phosphorus (TP) in treated wastewater during that period.* *The seasonal WQC can be beneficial to the environment because the demands for chemicals and energy will be lower to treat wastewater prior to discharging treated wastewater to receiving surface water with lower temperatures. It should be noted that when the chemical application rates become lower, the treated wastewater may contain lower amount of residual chemicals that do not react effectively with wastewater at lower temperatures. These facts are particularly true for the states in northeastern US, where surface water temperature can be lower than 10 degrees Celsius (50 degrees Fahrenheit) for months in a year as shown on Figure No. 1.* *[Figure 1]* *As stated above, without seasonal limits for cold months, much more chemicals (alum for coagulation and settling, soda ash for pH adjustment, polymers for thickening and dewatering, etc.), energy and associated sampling and testing are needed to achieve the same year-round limits in cold months, because the rates for chemical, biological and bio-chemical reactions are slower. As such, the cost to treat wastewater and to remove and dispose of additional sludge becomes much higher than summer months when water temperature is higher.* *Please also note that the production, transport and the use of more chemicals and energy can produce more negative impacts on the environment. Because those processes will produce more air, water and solids pollutants and wastes.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment. Temperature was not considered because of the lack of sufficient experimental data that could be used to develop an additional parameter in the MLR. Further, the EPA is aware of existing scientific information that indicates that temperature effects to toxicants may simply reflect time to observed effect, but not necessarily a lesser sensitivity to the magnitude of exposure (i.e., the concentration).	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0063 *(Kevin Oakes, Director of Wastewater, Borough of West Chester, Chester County, Pennsylvania)*	*The effects of low water temperature on aluminum toxicity are discussed below:* *1. At lower water temperature, the solubility of aluminum becomes lower, which lowers the toxicity of total aluminum.* *2. At lower water temperature, the chemical/biochemical reaction rates and the metabolic rates also become lower, which means lower rates of consumption and utilization by aquatic lives and therefore, lower overall toxicity of total aluminum.* *3. In accordance with Arrhenius' equation, the typical chemical reaction rate doubles for every 10 degree Celsius increase in temperature.* *Figure No. 1 above shows water temperature records (obtained from USGS Gaging Station 01480178) between January 2013 and July 2017, for the East Branch Brandywine Creek in southeast Pennsylvania. In general, the duration of water temperature below 50 degrees F ranges between four (4) and five (5) months (or longer) in a year.* *4. The results and conclusion of many aluminum toxicity studies on fishes at low water temperature (such as the research work by Antonio Poleo of the Department of Biology, University of Oslo, etc.) are well documented and published. However, those results and findings were not used by the USEPA to develop the proposed aluminum water quality criteria for various reasons (i.e. the quality of data, sampling and testing protocols do not agree with the standards established by the USEPA, or the article text are in foreign language, etc.).* *Nevertheless, we have attached for USEPA's review, a 2002 article published in the Journal of Limnology, entitled "Seasonal Variation in Mortality of Brown Trout (Salmo trutta) in an Acidic Aluminum-rich Lake" by Espen Lydersen, et al. of Norwegian Institute for Water Research. The authors of this article conducted extensive experiments in their research, their results also show the toxicity of aluminum becomes lower when water temperatures are lower.* *In light of the findings of many published aluminum toxicity*	Temperature was not considered because of the lack of sufficient experimental data that could be used to develop an additional parameter in the MLR. Further, the EPA is aware of existing scientific information that indicates that temperature effects to toxicants may reflect time to observed effect, not necessarily a lesser sensitivity to the magnitude of exposure (i.e., the concentration).	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	related scientific articles, it is our opinion that the USEPA research should include temperature as the fourth parameter as a part of the MLR analysis or for future WQC development. *Further, we believe the development and implementation of seasonal limits (or equivalent) for aluminum can be beneficial to the environment as discussed above.*		
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*EPA's description of aluminum environmental loadings, chemistry, and fate indicates most aluminum influx to aquatic environments comes from atmospheric sources via both wet and dry deposition and subsequent runoff from land. A total maximum daily load (TMDL) derived from the aluminum loadings within a watershed would allow little allocation for permitted discharges; understating acceptable aluminum concentrations in waters receiving permitted discharges because the MLR model is incomplete may result in costly and potentially ineffective mitigation efforts by dischargers.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	***Use of Water Effect Ratios*** *The appropriate use of the Water Effect Ratio (WER) procedure should be discussed in the Criteria Document. For some waterways, a WER would demonstrate that the form of aluminum typically found in stormwater (e.g. aluminum clays naturally bound to silicates, oxides and calcites) is not bioavailable or toxic. The states and permittees need clarification of if and when a WER would be appropriate.*	Research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The EPA briefly discusses this new research in the final 2018 aluminum criteria document. The 2018 final aluminum criteria reflects the current science and a larger database than a Water Effect Ratio applied to the superseded 1988 aluminum criteria. The Water Effect Ratio depends greatly on the particular "snapshot" conditions during the WER tests. The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The final criteria should recommend that states consider using the Water Effects Ratio (WER) procedure to determine if measured concentrations of Total Aluminum are actually in a bioavailable form and particularly where the ambient hardness and DOC fall outside the range of values used to develop the EPA's multiple regression model. It should be noted that the WER relies on the same test methods used to develop the recommended criteria and, when correctly applied, are not "less protective."*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment. The 2018 final aluminum criteria is reflective of a larger toxicity and water chemistry database than a WER, which can depend greatly on the limited and particular "snapshot" conditions during the WER tests.	No edits.
EPA-HQ-OW-2017-0260-0021 & EPA-HQ-OW-2017-0260-0022 *(Daryll Joyner, Administrator, Water Quality Standards Program, Florida Department of Environmental Protection (DEP))*	*The spreadsheet criterion calculator is very helpful in understanding the proposed criteria and how they were developed. However, as currently structured, it would be very cumbersome to adopt the calculator into a State's water quality standards rule or to implement it in a statewide 303(d) assessment. DEP recommends that EPA simplify the expression and calculation of the criteria into single equations for the acute and chronic criteria, if possible.*	The two MLR models (equations) are used to normalize the aluminum toxicity data for fish and invertebrates, and the criteria are calculated through the criteria calculator, not through direct use of the equations. It would be appropriate to reference Appendix K or the Aluminum Criteria Calculator in a State's water quality standards rule.	No edits.
EPA-HQ-OW-2017-0260-0025 *(Peter T. Goodmann, Director, Kentucky Division of Water)*	*The EPA recommends numeric criteria for aluminum at pH = 7, total hardness = 100 mg/L as CaCO3, and DOC = 1 mg/L. However, the recommended criteria vary as these three constituents change. States may find it impractical, or may even be prohibited by state administrative regulatory requirements to codify a model as a state water quality standard.*	The water quality characteristics that the EPA uses as a scenario throughout the document were simply selected as an example scenario. It would be appropriate to reference Appendix K or the Aluminum Criteria Calculator in a State's water quality standards rule.	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0036 *(Barry N. Burnell, Water Quality Division Administrator, State of Idaho Department of Environmental Quality (DEQ))*	*DEQ supports the use of a multiple linear regression model (MLR) to derive site and time-specific criteria. This approach has several advantages over black-box models (e.g., the biotic ligand model) for state implementations, including providing the public and regulated community the ability to calculate criteria based on site conditions without the need for specialized software. While the lookup tables and the Aluminum Criteria Calculator V.1.0 are useful tools, DEQ believes that the criteria statement should include, as an alternative option, the actual MLR equation used to derive aluminum criteria.*	Thank you for your comment. The two MLR models (equations) are used to normalize the aluminum toxicity data for fish and invertebrates, and the criteria are calculated through algorithms in the criteria calculator that reflect the 1985 Guidelines methods for criteria calculation from a sensitivity distribution of genera, not through direct use of the equations. It would be appropriate to reference Appendix K or the Aluminum Criteria Calculator in a State's water quality standards rule.	No edits.
EPA-HQ-OW-2017-0260-0040 *(Susan J. Sullivan, Executive Director, New England Interstate Water Pollution Control Commission (NEIWPCC))*	*Relating to the Aluminum Criteria Calculator, NEIWPCC requests that EPA clarify how the criteria will be expressed in surface water standards. It would also be helpful to understand how the criteria calculator can be used as part of a surface water quality standard. For example, additional clarity is needed for the following:* • *It is not clear what (or how many) inputs are needed to the Aluminum Criteria Calculator in order to adjust the criteria to local conditions. For example, the draft document does not provide a recommended number of samples needed to account for the effects of seasonality, diurnal water quality changes and/or site-specific variability on the input parameters for the MLR models used to derive aluminum criteria.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*8. The proposed guidance for aluminum is one that implements a multi-parameter approach (pH, hardness, DOC and aluminum). There are several areas to consider as it pertains to this type of guidance.* *a. Implementation of such a guidance must be carefully explored as the impacts to development of numerical criteria in National Pollutant Discharge Elimination System (NPDES) permits which already require in-depth calculations for development, will now have to evaluate based on multiple water quality parameters, and the regulated community may have to increase monitoring for these additional parameters.* *b. Additional resources for State and EPA regulatory staff may be incurred to develop appropriate criteria in NPDES permits that reflect the protective limits of aluminum as well as a need for guidance for implementation of NPDES permits. In order to incorporate the new criteria into NPDES permits, reasonable*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). As noted in the criteria document, the EPA decided to use an empirical MLR approach in the aluminum criteria update rather than a BLM model due to: 1) the relative simplicity and transparency of the model, 2) the relative similarity to the available BLM model outputs, and 3) the decreased number of input data on water chemistry needed to derive criteria at different sites. The EPA is also separately compiling an updated national database of water chemistry conditions relevant to the MLR model: hardness, pH and DOC, and will make that data available to in the future to support states and stakeholders needs for model input data, when their own data are not available. The implementation documents that the EPA is also	No edits.

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	potential calculations will need modification to account for the multi-parameter approach to aluminum. *c. Consideration must be given to the implementation of water quality standards across boundaries. The State of New Mexico poses a unique scenario as it has shared waters with four states, a downstream country and 23 Tribes; all of which have the authority to adopt and impose water quality standards of their own to which the Waters of the State must consider and adhere to as they cross jurisdictional boundaries. The ability to coordinate maintaining water quality standards using this multi-parameter process will be challenging given the numerous entities involved.* *d. The multi-parameter approach employs the use of dissolved organic carbon (DOC). Currently, the laboratory to which the State uses for analytical analysis is not equipped to analyze DOC. If the State were to consider implementing the new guidance, it would require additional resources to retain a laboratory capable of conducting DOC analysis. This issue is also applicable to permittees and organizations that collect data which is submitted to the State for use in assessment.* ***Implementation guidance will need to address issues wherein resources are not readily available to states and tribes (and their labs) to use the criteria calculator****.*	developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	
EPA-HQ-OW-2017-0260-0046 *(Jennifer Wigal, Program Manager, Water Quality Standards & Assessments, Oregon Department of Environmental Quality)*	*The criteria recommendation document states that "when any of the water quality parameters selected is 'outside model inputs', the Aluminum criteria calculator ... provides the user a warning to use discretion in applying criteria in those conditions." (p. 72). This indicates that states have discretion whether or not to apply criteria values generated in the extrapolated range of the input parameters as regulatory criteria. EPA should clearly state that they are reserving for states the discretion to apply, or not to apply, criteria values generated using inputs outside the validated range as regulatory criteria. The current reference to "generated warnings" is ambiguous.* *In other words, EPA is allowing states to decide the bounds of the criteria calculator they wish to use beyond the calibrated range of the model (6.5 to 8.5). Only criteria values that are valid for regulatory use should be included as part of the recommended criteria. A calculator for research purposes with extended non-regulatory parameter ranges should instead be provided as a*	Thank you for your comments. Since the draft document was released in 2017, additional toxicity tests were conducted with *Ceriodaphnia dubia* and *Pimephales promelas* thereby expanding the water chemistry empirical data used for model development. As a result, the recommended bounds have changed. The water chemistry bounds for the 2018 criteria were thus expanded, with details and rationale provided in the criteria document. These bounding approaches for hardness, DOC and pH are reflected in the criteria lookup tables. These approaches were taken so that the recommended criteria can be provided for, and will be protective of, a broader range of U.S. natural waters. Recommended extrapolated criteria values outside of the empirical data tend to be lower values and will be more protective of the aquatic environment. Criteria values estimated outside of the range of the empirical data are more uncertain. The calculator provides warning	Aluminum Criteria Calculator

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	supplement. DEQ agrees that in no case should input values outside the extrapolated ranges (i.e. outside pH 5.0- 9.0) be used to generate regulatory criteria.	when outside the bounds of extrapolated data and future implementation guidance addresses this point also.	
EPA-HQ-OW-2017-0260-0051 *(Douglas E. Fine, Assistant Commissioner for Water Resources, Massachusetts Department of Environmental Protection (MassDEP))*	*4. Implementation: Standards Adoption – User Guidance for Criteria Calculator – EPA created a user-friendly Aluminum Criteria Calculator V.1.0 (Aluminum Criteria Calculator V.1.0.xlsx). EPA should explain in the guidance document how this criteria calculator can be adopted into a surface water quality standard. It is requested that EPA clarify the preferred approach for how the criteria will be expressed in surface water standards (e.g., as an equation, calculator, look up table, regional criteria based on monitoring). An example of the preferred approach will be helpful to states as they move to adopt these criteria.* *It is not clear what inputs are needed to Aluminum Criteria Calculator V.1.0 in order to adjust the criteria to local conditions. For example, the draft document does not provide a recommended number of samples needed to account for the effects of seasonality and/or site-specific variability on the input parameters for the MLR models used to derive aluminum criteria.* *It is also not clear how multiple samples from a site should be used in the Aluminum Criteria Calculator. For sites with multiple input datasets (i.e., pH, hardness and DOC collected at different times), would the approach for the calculator be similar to the approach for the BLM for copper? Should users enter multiple input datasets from one site into the calculator to generate multiple CMC and CCC criteria and then derive final CMC and CCC criteria using appropriate summary statistics?*	Another tab was added to the Aluminum Criteria Calculator that provides instructions. It would be appropriate to reference Appendix K or the Aluminum Criteria Calculator in a State's water quality standards rule. The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	Aluminum Criteria Calculator "Read Me" tab
EPA-HQ-OW-2017-0260-0028 *(Joshua D. Schimmel, Executive Director, Springfield Water and Sewer Commission (SWSC))*	*The SWSC recommends including guidance on how the criteria should be applied to setting a discharge limit in a NPDES permit. Ever-changing water quality values of DOC, hardness, and pH will result in an ever-changing allowable limit. How will samples be used to determine permit limits?*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them	No edits.
EPA-HQ-OW-2017-0260-0028 *(Joshua D. Schimmel, Executive Director, Springfield Water and Sewer Commission (SWSC))*	*If the new criteria is approved they should be included in individual permits issued under the NPDES program for water treatment facilities.*		

Comment Number (Organization)	Public Comment on Topic 18: Regarding implementation issues	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		available for public comment.	
EPA-HQ-OW-2017-0260-0030 *(Nelson Brooke, Riverkeeper et al., Black Warrior Riverkeeper)*	*In the absence of site-specific, historic data for pH, DOC, and hardness at sites of interest, which is a particular problem here in Alabama where there is dearth of reliable water quality data, regulators, consultants, or non-profits aiming to enforce water quality criteria will be forced to sample and analyze each of the four necessary variables just to get a measurement for the site-specific criteria, rather than simply comparing the analysis for aluminum to the predetermined water quality criteria under the current recommendation. The increase in necessary analysis will result in a significant increase in the time spent collecting samples in addition to drastically increasing the cost of analysis for regulators and other interested parties. While this increase in cost may not be a significant problem for many well-funded federal or state agencies, it could place an undue burden on organizations with limited budgets, such as ours, and some state agencies, like the Alabama Department of Environmental Management, that are woefully underfunded.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). As noted in the criteria document, the EPA decided to use an empirical MLR approach in the aluminum criteria update rather than a BLM model due to: 1) the relative simplicity and transparency of the model, 2) the relative similarity to the available BLM model outputs, and 3) the decreased number of input data on water chemistry needed to derive criteria at different sites. The EPA is separately compiling an updated national database of water chemistry conditions relevant to the MLR model: hardness, pH and DOC, and will make that data available to in the future to support states and stakeholders needs for model input data, when their own data are not available. The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0030 *(Nelson Brooke, Riverkeeper et al., Black Warrior Riverkeeper)*	*Furthermore, there is an inherent standard of error in any measurement of water quality parameter. While a single measurement for aluminum would carry but a single standard of error, requiring four separate measurements, each with its own standard of error, to calculate a single, site-specific criteria, will mean that the error inherent in each measurement is compounded in the final criteria calculation. This means that the standard of error in the site-specific criteria will be much greater than that of a single measurement resulting in a criteria calculation that carries a high degree of uncertainty.*	The multiple measurements (Al, pH, total hardness and DOC) are necessary to account for the bioavailability and toxicity of aluminum, based on the current science. A single criterion value for aluminum is no longer thought to represent the best available science, and would result in over-protection in some cases, and under-protection in others, depending on the water chemistry at a location.	No edits.

Comment Number (Organization)	**Public Comment on Topic 18: Regarding implementation issues**	**EPA Response**	**Revision Location in 2018 Aluminum Criteria Document**
EPA-HQ-OW-2017-0260-0038 *(Jennifer Pederson, Executive Director, Massachusetts Water Works Association et al.)*	*We think it is important for EPA to define the "site" for sampling the water quality parameters that are input into the model. We understand that the samples for the water quality parameters (hardness, TOC, DOC, pH) should be done in the receiving waters and not from the discharge, but EPA should make that explicit in the final document.*	The 2018 aluminum criteria are Ambient Water Quality Criteria, as is explicitly stated in the document's title. The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). The implementation documents that the EPA is developing are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	No edits.
EPA-HQ-OW-2017-0260-0036 *(Barry N. Burnell, Water Quality Division Administrator, State of Idaho Department of Environmental Quality (DEQ))*	*DEQ also requests that EPA develop guidance on implementation of the MLR to assist states that may be considering adoption of the revised aluminum criteria. Although time and site-specific criteria are not new, recent adoptions of these types of criteria have highlighted several implementations issues, such as identifying critical conditions, determining minimum data requirements, how to reconcile variable criteria for permitting purposes, and site delineation. EPA should provide clear guidance and options for states seeking to adopt these criteria, rather than requiring states to solve these issues as a prerequisite to adoption of the EPA recommended criteria.*		

TOPIC 19: Comments regarding implementation issues with measuring aluminum

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0013 *(Ricardo Cantu, President, OspreyOwl Environmental, LLC)*	*I have been sampling rivers in New Hampshire and Massachusetts (using clean sampling techniques) since 2009. The majority of the sampling focused on aluminum, with minor sampling for copper and lead. My initial sampling efforts focused on adoption and use of Method 1669.* *The EPA had proposed in the 2007 NPDES draft for the City of Manchester an aluminum limit of 87 ug/l indicating the Merrimack River was impaired for aluminum. A one-year study was undertaken by the City of Manchester using the "Clean Sampling" techniques. Even with the use of these techniques, samples had to be occasionally corrected for ambient environmental conditions. A final report was issued with the data collected over a year's time. The findings indicated that the Merrimack River, in the location of Manchester, was not impaired for aluminum and the proposed limit was dropped in the subsequent NPDES issuance.* *The next permit draft issued in 2012 for Manchester included copper and lead as permit parameters. Another "Clean Sampling" event was undertaken and subsequently lead was dropped from the permit with Copper being raised over eight fold from the proposed WQ limit.* *Clean sampling has made a big difference in findings for all metals parameters measured in collected samples. The draft Aluminum Criteria has the following information regarding ambient aluminum during sampling events. "Average total aluminum concentrations in the atmosphere were observed to range from 0.005 to 0.18 µg/m3 (Hoffman et al. 1969; Potzl 1970; Sorenson et al. 1974). These concentrations are dependent on the location, weather conditions and industrial activity in the area with most of the airborne aluminum present in the form of small suspended particles of soil (dust) (ATSDR 2008).* *Average total aluminum precipitation concentrations reported in the rural area (107.2 µg/L, range of 28.8-222.7 µg/L) were higher than observed in the urban area (83.9 µg/L, range 35.8-125.4 µg/L). Samples of wet deposition collected in semi-rural Dexter, Michigan had an average mean total aluminum concentration of 57 µg/L (Landis and Keeler 1997).*	Thank you for your comment.	No edits.

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Much lower levels of total aluminum were found in rainfall samples collected in Japan during 2000 and 2002 where average concentrations ranged from 2.71 to 6.06 µg/L (Takeda et al. 2000; Vuai and Tokuyama 2011). Atmospheric precipitation (i.e., rain and snow) samples collected in the U.S. have contained up to 1,200 µg/L total aluminum (Dantzman and Breland 1970; DOI 1971; Fisher et al. 1968; USGS 1964).”		
EPA-HQ-OW-2017-0260-0020 *(Jon Tack, Chief, Water Quality Bureau, Iowa Department of Natural Resources (DNR))*	*The EPA draft criteria are expressed as total aluminum, which is not the best measure of the bioavailable aluminum concentration. Aluminum tied up in minerals and adsorbed to clay particles is not biologically available in natural waters. The use of total aluminum concentration could overestimate the potential risks of toxicity to aquatic organisms.* *Please define total aluminum concentration and the differences among total aluminum, total recoverable aluminum and acid-soluble aluminum concentrations.*	The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. The accepted EPA methods 200.7 and 200.8 for total aluminum are used to determine compliance with effluent limitations and also have filtration performed after acidification. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as	Section 2.6.2
EPA-HQ-OW-2017-0260-0020 *(Jon Tack, Chief, Water Quality Bureau, Iowa Department of Natural Resources (DNR))*	*Iowa understands that research on testing methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) being included in the total recoverable aluminum concentrations. In the meantime, States should have the flexibility to apply testing methods that only measure the potentially bioavailable portion of aluminum without the unavailable portion of aluminum tied up in minerals or clay.* *Question: can States express aluminum criteria as acid-soluble aluminum since acid-soluble aluminum is the recommended criteria for other metals?*		
EPA-HQ-OW-2017-0260-0023 *(Stan Dempsey Jr., CMA President, Colorado Mining Association (CMA))*	*The EPA has proposed the criteria be applied as the total recoverable form of aluminum. CMA has significant concerns with this approach because a total recoverable analysis will unquestionably be measuring both toxic and nontoxic forms of aluminum in the sample. Aluminum is the third most abundant element in the earth’s crust. However, the majority of this aluminum is bound in the mineralogy of the rock and sediment particles that make up the crust and is unavailable for uptake by aquatic life. Use of the total recoverable analytic method means that some portion of the result will be accounting for this unavailable aluminum that it bound within the rocks and sediments.* *Colorado is subject to both significant snowmelt events and intense*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	precipitation events that, coupled with steep topography and erodible surfaces, can cause high sediment loads in the rivers and streams. Flows in streams and rivers that contain high suspended sediments will show proportionally high aluminum concentrations. Use of a total recoverable method is unacceptable and presents numerous issues with implementation in 303(d) assessments and NPDES permits. EPA needs to find an alternative analytic method for measuring aluminum that is limited to the biologically available and toxic form of aluminum.	Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters. The EPA has clarified aluminum terminology in the 2018 final aluminum criteria document. EPA asserts that the 2018 final aluminum criteria, which reflects the current and best available science and allows incorporation of local water chemistry considerations, is more scientifically defensible than the Water Effect Ratio applied to the superseded 1988 aluminum criteria.	
EPA-HQ-OW-2017-0260-0025 *(Peter T. Goodmann, Director, Kentucky Division of Water)*	*As stated in Multiple Linear Regression (MLR) Models For Predicting Chronic Aluminum Toxicity To Freshwater Aquatic Organisms and Developing Water Quality Guidelines, Environ. Toxicol. Chem., (DOI: 10.1002/etc.3922), p. 20:* *"... although the Al toxicity data used to develop the MLR models and HC5s described in this evaluation are based on total Al concentrations in laboratory waters, it is inappropriate to analyze total Al concentrations in natural waters for comparison. This is because many natural waters contain Al in mineral forms, such as clays and other suspended particles, which are non-bioavailable ..."* *However, the EPA draft criteria does not address how these recommended criteria apply in areas where much of the aluminum exists in mineral form and is therefore non-bioavailable. The DOW believes that further clarity and guidance is needed in this respect.*		
EPA-HQ-OW-2017-0260-0027 *(Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))*	***Adverse effects of the current aluminum criteria*** *The current (1988) criteria are significantly overprotective. This can lead to waterways being classified as exceeding water quality standards when they contain normal concentrations of aluminum derived from natural sources. Aluminum is naturally present in California soils at an average concentration of approximately 7.3%. The aluminum criteria are based on total recoverable aluminum and therefore the monitoring results include the aluminum derived from acid digestion of soil particulates washed into the waterways or scoured from stream channels. Consequently, measured total aluminum concentrations commonly exceed the current standards in water quality samples from streams during wet weather when turbulent flows increase the level of suspended sediment. Concentrations of 20 mg/l of total suspended solids (TSS) comprised of natural mineral materials present in a waterway would exceed the current Criterion*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Maximum Concentration (CMC) (acute) criterion of 750 µg/L. TSS concentrations in natural waterways are generally much greater than 20 mg/L during wet weather. (See data for TSS in undeveloped streams in Attachment A). *A historical evaluation of aluminum in Ventura County waterways provides an example of the pervasive exceedances of the current criteria in natural and urban waterways. The Ventura Countywide Stormwater Quality Management Program (VCSQMP) prepared an assessment of aluminum in three major watersheds. [Larry Walker Associates. 2014. Historical Data Evaluation of Aluminum in the Ventura River, Santa Clara River, and Calleguas Creek Watersheds. June.] This assessment found that 74.2 percent of all wet weather water quality samples collected by the VCSQMP exceeded 1,000 µg/L. However, in natural watersheds upstream from anthropogenic activities, 100% of wet weather samples exceeded 1,000 µg/L.* *Although the Regional Water Boards in California have not formally adopted the 1988 aluminum criteria as water quality standards, the current EPA recommended standards have affected National Pollutant Discharge Elimination System (NPDES) permittees in the state. The 750 µg/L CMC (acute) criterion for total aluminum is used a benchmark for several categories of discharges in EPA's Multi-Sector General Permit (MSGP). The State Water Board has used this MSGP benchmark as a Numeric Action Level (NAL) in the statewide stormwater Industrial General Permit. [California State Water Board. 2014. General Permit for Discharges Associated with Industrial Activities(NPDES No. CAS000001)] As discussed above, the presence of relatively minor concentrations of TSS from natural soils in industrial site runoff will cause an exceedance of the NAL for aluminum. As specified in the Industrial General Permit, this exceedance of the NAL triggers an exceedance response action (ERA) that includes an evaluation by an outside party and identification of any additional BMPs and SWPPP revisions necessary to prevent future NAL exceedances. Continuing exceedances require even more extensive responses. The Industrial General Permit includes an Annual NAL of 100 mg/l for TSS. If the TSS is composed of only natural soils, the aluminum concentration will be approximately 7,300 µg/L, which obviously exceeds the NAL of 750 µg/L. Consequently, compliance with the NAL presents a significant challenge for industrial*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	permittees even though the exceedances are well within the range of natural aluminum concentrations and are very unlikely to have an adverse effect on the waterways. *In California, the EPA recommended aluminum criteria have also been used to evaluate or translate narrative toxicity objectives in the Water Quality Plans into numeric effluent limits in some NPDES permits. [Example: California Regional Water Quality Control Board, Central Valley Region. 2010. Waste Discharge Requirements for the Sacramento Regional County Sanitation District, Sacramento Regional Wastewater Treatment Plant, Elk Grove (NPDES No. NPDES No. CA0077682). When reissued in 2016 as Order R-5-2016-0020, the aluminum effluent limits were removed based on the reasonable potential analysis (RPA), which was partially based on the acute criterion of 750 µg/L.] This has not yet occurred for stormwater permits, however, numeric effluent requirements are increasingly being used in stormwater permits in conformance with EPA guidance that emphasizes measurable permit requirements and, where feasible, numeric effluent limitations. [EPA Memorandum to Water Division Directors. 2014. Revisions to the November 22, 2002 Memorandum "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs". November 26.]*		
EPA-HQ-OW-2017-0260-0027 (Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))	*An additional concern is that stormwater permittees in the future may need to implement Wasteload Allocations (WLA) for aluminum as specified in TMDLs. Currently, nine waterways in California are included on the 303(d) list for impairment by aluminum. In TMDLs, the WLAs are often established as numeric effluent limits at the EPA criterion value. Because of the ubiquitous nature of aluminum, these WLAs may be very difficult to achieve.*		
EPA-HQ-OW-2017-0260-0027 (Jill Bicknell, Chair, California Stormwater Quality Association (CASQA))	*New Mexico, with approval from EPA, has implemented aluminum standards that use filtration to remove or minimize the "mineral phases" present in the sample. This approach will reduce the natural particulates and other soil residue that normally carry a significant portion of the aluminum but that do not present risk to aquatic organisms. This is appropriate because aluminum toxicity is associated with dissolved aluminum with the exception of low pH waterways.* *The New Mexico hardness-adjusted acute criteria are the same as*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	those in Colorado [The New Mexico hardness-adjusted chronic criteria differ from those in Colorado.] and similarly, the hardness range extends higher than the 150 mg/L cap used in the EPA Aluminum Notice: *The filtration step prior to analysis is described in the New Mexico standards:* *For aluminum, the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize mineral phases as specified by the department. The EPA has disapproved the hardness-based equation for total recoverable aluminum in waters where the pH is less than 6.5 in the receiving stream for federal purposes of the Clean Water Act.* *Naturally occurring high levels of aluminum in some waterways, especially during wet weather, is the major reason to consider some form of filtration prior to analysis. Aluminum is the third most abundant element in the earth's crust and is commonly present in surface waters, especially during wet weather when soils are mobilized by the increased flows. This is particularly true in California because of the distinct wet and dry seasons. During dry weather, flows typically decrease significantly and sometimes cease. Wet weather flows are usually much greater than dry weather flows and often tend to scour the stream beds and mobilize suspended solids. This phenomenon can be seen in the following TSS measurement from natural waterways in Southern California. The table below includes the five highest values from the 17 waterways in Attachment A:* *The Sespe Creek mean DOC is 5.53 mg/L. The approach in the Aluminum Notice, with caps on the DOC and hardness values, results in an acute criterion of 4,700 µg/L (assuming pH 8.0 and hardness = 150 or higher). However, if the TSS in the waterway is composed of natural soils containing the California average of 7.3% aluminum, the resulting concentration will be 3,793 mg/L or 3,793,000 µg/L. Thus, the natural aluminum loading exceeds the proposed criterion by almost three orders of magnitude.* *Arroyo Sequit had a lower concentration of 461 mg/L TSS and the resulting total recoverable aluminum concentration will be about 34 mg/L based only on the suspended solids or 33,650 µg/L. This*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	value also greatly exceeds the acute criterion of 4,100 µg/L (assuming pH = 8.0 and a relatively low hardness = 25 mg/L). It is not realistic or appropriate to establish water quality criteria that are routinely exceeded in natural waterways. *Some dissolved aluminum will be present, which will increase the exceedance even more. It appears essential, at least in high TSS waters, to provide a method for decreasing the interference from natural background aluminum as is done in New Mexico. It may be appropriate to use this approach for waters with pH greater than 6.0 or 6.5 because low pH facilitates partitioning to the dissolved phase.* *Another approach to eliminate the natural sources has been previously used in some California permits. [For example, see Central Valley Regional Water Board. 2012. Big Creek Powerhouse No. 1 Domestic Wastewater Treatment Plant, Order R5-2012-0048, NPDES No. CA007954.] These permits included the following methodology for measuring aluminum.* *Compliance with the final effluent limitations for aluminum can be demonstrated using either total or acid-soluble (inductively coupled plasma/atomic emission spectrometry or inductively coupled plasma/mass spectrometry) analysis methods, as supported by USEPA's Ambient Water Quality Criteria for Aluminum document (EPA 440/5-86-008), or other standard methods that exclude aluminum silicate particles as approved by the Executive Officer. [emphasis added]* *Clay is typically a naturally-occurring hydrated aluminum silicate (Al2O3SiO2 x H2O). Removing the aluminum silicate particles, often colloidal, will remove much of the background aluminum and result in a more accurate assessment of toxicity. As before, this method may not be appropriate for low or very high pH waters. Most inland waterways in California appear to have pH between 7.0 and 8.0.* *We strongly propose that EPA complete an assessment of the actual toxicity of non-soluble aluminum mineral compounds in natural soils. Aluminum silicate, aluminum calcite, aluminum oxide and aluminum phosphate are very unlikely to remain in solution at pH values between 6.0 - 9.0. These results should be*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	used to reassess the decision to base the criteria on total recoverable aluminum.		
EPA-HQ-OW-2017-0260-0029 *(Hall & Associates on behalf of Minnesota Environmental Science and Economic Review Board (MESERB))*	*The Draft Criteria acknowledge several other areas of uncertainty that warrant use of water effect ratios to clarify that uncertainty when the draft criteria are used to identify waters as impaired or used in the derivation of water quality-based effluent limits. Several of these areas of uncertainty are identified below.* *Aluminum chemistry in surface waters is highly complex, and so measurement uncertainty can be high if only one form of aluminum is taken into account. A thorough understanding of aluminum toxicity is complicated by the ability to distinguish between aqueous and particulate aluminum, and between inorganic and organic forms of aluminum (Driscoll and Postek 1996; Gensemer and Playle 1999). (Draft at 22)* *The unique chemistry of aluminum (speciation changes and the transient precipitates formed during toxicity testing) and difference between geological aluminum materials suspended in natural water are additional areas of uncertainty (Angel et al. 2016; Cardwell et al. 2017; Gensemer et al. 2017). The use of total aluminum concentrations is justified for laboratory toxicity test data (see Section 2.6.2); where the total aluminum concentration is in either a dissolved or particulate form (Santore et al. 2017). However, natural water samples may also contain other species of aluminum that are not biologically available (i.e., suspended particles, clays and aluminosilicate minerals) (Santore et al. 2017; Wilson 2012). This creates uncertainty because the total aluminum concentrations measured in natural waters may overestimate the potential risks of toxicity to aquatic organisms. (Draft at 69)* *As discussed in the Draft, the complex chemistry of aluminum presents special problems in characterizing the toxicity of aluminum in response to changing pH, hardness and DOC. Filtration studies with fathead minnows show that toxicity is greater in unfiltered water (Draft at 21), indicating that, unlike most other metals, particulate aluminum contributes to the overall toxicity of the sample. We would expect that in these laboratory studies, aluminum hydroxide was the primary particulate form. Other particulate forms found in natural waters (clays, alumino-silicates) are unlikely to show the same level of toxicity. Consequently, application of the proposed criteria to waters*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	containing these non-biologically available forms of aluminum will overestimate the toxicity of aluminum in these waters. As with the existing aluminum criterion, the proposed criterion should include a warning that water effect ratios may be appropriate for assessing the actual toxicity of aluminum in these waters.		
EPA-HQ-OW-2017-0260-0031 *(Robert P. Baumgartner, Regulatory Affairs Department Assistant Director, Clean Water Services (District))*	*Aluminum concentrations in natural surface waters can be strongly affected by the minerals in the river bed, natural upland runoff, dust from the atmosphere and natural groundwater inflows. As stated in the Request for Scientific Views, aluminum is the third most abundant element and the most abundant metal in the Earth's crust. Although abundant in the crust, aluminum is rarely present in a dissolved form in surface waters that are not acidic. In the crust, aluminum exists predominantly in aluminosilicate minerals, including feldspar and mica, which weather into a wide variety of clay minerals. These clay minerals are abundant in soils and in the aquatic environment in particles on the order of a few micrometers (µm) to small fractions of a µm in size. In all these mineral forms, aluminum is strongly bound in the mineral's crystal structure. In these solid phases, aluminum is not as biologically available (if at all) as it is in the dissolved, ionic forms or the chemically precipitated forms that are used in assessing aluminum toxicity in the laboratory. It is invalid to apply criteria based on dissolved, biologically available aluminum to waters where the aluminum is often present in an entirely different form.* *The small size and ubiquity of clay particles in the environment complicate the measurement of the bioavailable aluminum present in surface waters. Conventional sample filtration (using a 1-µm or 0.45-µm filter) may reduce but will not eliminate suspended clays present in colloidal form which includes most clay particles. Performing a "total" aluminum analysis by acid digestion of a water sample containing suspended clays, even if filtered using conventional methods, will overestimate the amount of aluminum that is actually in solution. Using conventional filtration to define "dissolved aluminum" as defined in the EPA rule or using total aluminum analyses of surface waters will thus lead to listing of water bodies as water quality limited for aluminum, when in fact the bulk of aluminum in many streams may not be in a toxic form. Listing streams as water quality limited imposes significant costs on dischargers to those streams. Such costs include effluent treatment and product substitution (e.g. discontinuing the use of alum that aids in nutrient removal and replacing with other*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	chemicals or processes). While this may be a necessary burden to protect water quality in waterbodies where aluminum is harming aquatic life, many waterbodies contain clay-dominated soils and other sources of aluminum forms that are not biologically active or are at least much less biologically active than dissolved forms. Listing these streams as water quality limited for aluminum and imposing burdens on dischargers would do little to nothing to improve water quality and protect aquatic life, in these situations. As an example, using the aluminum criteria calculator provided by EPA, we analyzed aluminum samples in the receiving waterbody and in effluents from our four treatment plants. The receiving waterbody would nearly constantly exceed the proposed chronic criteria, while the effluent from all four treatment plants would not, except for a single sample over the last 10 years (out of hundreds). Therefore, under the proposed criteria, the effluent would apparently be less toxic than the receiving waterbody as far as aluminum goes, even though almost all of that aluminum in the receiving waterbody is likely coming from the clay-dominated soils in the watershed and is much less biologically active (if at all) than the aluminum in the effluent which comes primarily from seasonal alum treatments. This is likely to be the case in many watersheds with abundant natural sources of aluminosilicates such as clays.		
EPA-HQ-OW-2017-0260-0031 *(Robert P. Baumgartner, Regulatory Affairs Department Assistant Director, Clean Water Services (District))*	*To avoid listing these streams unnecessarily and imposing the associated burdens on discharges unnecessarily, EPA should provide states the flexibility to define their aluminum water quality criteria to avoid "false positives" (total aluminum concentrations that would exceed the aluminum criteria even when very little is biologically active). This flexibility should include the ability to establish criteria based on truly dissolved aluminum using alternative filtration methods to remove colloids, prescribe analytical methods that measure only toxic forms of aluminum in the water column, and critically evaluate historic data in making water quality limited determinations. Only data that reflects the presence of aluminum in toxic forms should be used in making listing determinations.*		
EPA-HQ-OW-2017-0260-0032 *(Phillip M. Gonet, President, Illinois Coal Association (ICA))*	*The Illinois Coal Association (ICA) appreciates the opportunity to respond to the EPA's Request for Scientific Views on the Draft Aquatic Life Ambient Water Quality Criteria for Aluminum (Draft Criteria). The ICA is a trade association responsible for the promotion of the Illinois coal industry. In 2016 ICA Members were responsible for over 95% of the coal produced in Illinois, contributing over $1.5 billion to the state's economy.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	The following are our concerns for the Draft Criteria. *The EPA has proposed the criteria with the total recoverable form of aluminum. This analytic method measures both toxic and nontoxic forms of aluminum in the sample because it uses an acid digestion that will incorporate the nontoxic aluminum contained in the sediment particles. Illinois is dominated by agriculture and as a result, many streams receive runoff during precipitation events that is high in suspended sediment. Measuring the aluminum that is bound in these clays and silts will overestimate the toxicity of the water. A moderate amount of suspended sediment in a sample can cause a significant increase in aluminum above the criteria. <u>EPA should use an alternative form of aluminum in the criteria</u>. In determining what form of aluminum is more appropriate, EPA should consider the level of difficulty associated with its sampling and analysis. For example, use of dissolved method is already widely accepted by laboratories and industry.*		
EPA-HQ-OW-2017-0260-0032 *(Phillip M. Gonet, President, Illinois Coal Association (ICA))*	*EPA should also include some discussion of how the analytic method can be implemented into NPDES permits. Permittees should not be required to translate the aluminum to total form for incorporation into the NPDES permit. For aluminum, the requirement for translator studies should be made consistent with current scientific views that the bioavailable form of aluminum is the primary concern, and not the form associated with the suspended sediment.*		
EPA-HQ-OW-2017-0260-0034 *(James Boswell, Senior Manager, Environmental, Peabody Energy)*	*The EPA draft criteria are based on the total form of aluminum. This will present issues with samples containing high suspended sediment loads, which is the majority of samples collected during or following precipitation or snowmelt events. EPA indicates that use of the dissolved fraction alone is likely to underestimate the potential for toxic effects of aluminum. However, use of the total recoverable or total fraction will significantly overestimate the bioavailable fraction of aluminum, particularly for samples that contain elevated sediment concentrations. Many regions of the U.S. show elevated sediment loads during intense precipitation or snowmelt events. As noted in the draft criteria, many of these sediments contain aluminum in their structure, which will be measured using the total or total recoverable analytic methods. For example, the arid west contains many highly erosive environments and streams convey significant sediment loads following storm events. Peabody mining operations have collected*	The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures	No edits.

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	water quality samples from upstream undisturbed areas that have sediment concentrations on the order of 10,000 mg/L or more (Table 1). The sediment in these samples contains significant amounts of aluminum that exceeds the EPA draft criteria even though it is biologically unavailable to aquatic life. Similarly, in the Midwest region where agriculture dominates the landscape, runoff from fields will contain significant amounts of clays and silts that will cause an exceedance of the aluminum criteria, even though the majority of the chemical cannot be taken up by aquatic life. *EPA must provide more extensive discussion of the uncertainty associated with total and total recoverable methods, how this uncertainty impacts interpretation of the analytic results, and how criteria implementation can be used to account for this. Furthermore, EPA should explore whether an alternative analytic method, such as the acid soluble method or a prefiltration method using a larger filter pore size than the traditional dissolved analysis, are more appropriate for aluminum. Final issuance of any criteria without addressing these issues will be premature and lead to false positives at discharge facilities and inaccurate 303(d) listings. State agency and industry resources will be wasted studying areas with high aluminum levels and investigating and implementing treatment systems where there may not be any actual adverse impact on the aquatic life. EPA must provide an alternative to the use of a total recoverable analysis to avoid the numerous potential issues with implementation.*	total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters. The EPA has clarified aluminum terminology in the 2018 final aluminum criteria document.	
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	*This comment document prepared by the Nevada Division of Environmental Protection (NDEP), Bureau of Water Quality Planning (BWQP) provides discussion of an overall concern, along with a numbered set of sequential technical comments on EPA's draft document.* *The main concern is the type of sample (i.e., field-filtered or not) and the corresponding form of aluminum (i.e., dissolved or total) that would be used to assess waterbodies. The 2017 criteria document seems confused about what constitutes "dissolved" versus particulate forms of aluminum ("total" is assumed to be the sum of dissolved plus particulate). The operational definition of "dissolved" is agreed upon as, that portion passing through a 0.45-µm membrane filter; however, this* ***requires field filtering*** *prior to acidification of the sample. Filtering a sample* ***after*** *it has*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	been acidified is never considered to represent the dissolved portion (operationally defined as above) as it exists in the natural water.		
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	***Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria (EPA 1993)*** *EPA's technical guidance (1993) stated that it "is now the policy of the Office of Water that the use of dissolved metal to set and measure compliance with water quality standards is the recommended approach, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal." EPA's 1993 guidance acknowledged that some practitioners questioned use of dissolved only because "…it neglects the possible toxicity of particulate metal." However, EPA replied that studies have shown particulate metal to be "substantially less" toxic than dissolved metal, and that any error incurred from excluding particulate metal would "…be compensated for by other factors which make criteria conservative."* *The 1993 guidance further specified that, "any error incurred from excluding the contribution of particulate metal will generally be compensated by other factors which make criteria conservative. For example, metals in toxicity tests are added as simple salts to relatively clean water. Due to the likely presence of a significant concentration of metals binding agents in many discharges and ambient waters, metals in toxicity tests would generally be expected to be more bioavailable than metals in discharges or in ambient waters." The guidance also stated that, "tests used in the derivation of water quality criteria for aquatic life; in particular, the pH had to be between 6.5 and 9.0, and the concentrations of total organic carbon (TOC) and total suspended solids* ***(TSS) had to be <u>below</u> 5 mg/L****. Thus most data generated using river water would not be used." Finally, EPA (1993) noted that, "***The use of dissolved metal in water quality standards gives a more accurate result***." A brief summary of EPA's 1988 criteria document for aluminum is provided below for context.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0041 *(John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))*	***NDEP's Overall Concern Regarding Use of "Total" Aluminum in the 2017 Draft Criteria*** *The definitions of "dissolved" and "total" given on pages 3 and 4 of the 2017 draft document seem to agree with those used by the NDEP, as long as samples are filtered in the field prior to acidification. NDEP defines "dissolved" as constituents in a water sample that has been collected by field filtering through a 0.45-µm membrane filter prior to acidification for preservation. NDEP defines "total" as constituents measured in a water sample that has been collected without filtration into a pre-acidified sample bottle. NDEP notes that the distinction between "dissolved" and "total" is critical in the implementation of the criteria for aluminum (and most other metals).* *Acidifying unfiltered samples typically results in desorption from, and dissolution of, particulates included in the sample, thereby releasing sorbed and particulate metals into solution. Most metals are highly soluble in pH 1.5-2.0 waters. In effect, acidifying unfiltered samples artificially raises (sometimes substantially, in the case of samples with significant levels of suspended solids) the load of "dissolved" metals. This means a sample that is not field-filtered is likely to include iron oxides and alumino-silicate minerals, such as clays, along with sorbed metals. After acidification and dissolution of suspended particulates, the once-particulate metals are now considered as part of the "dissolved" load to which aquatic organisms are exposed. This will likely overestimate the true concentrations of dissolved aluminum (and other metals) to which aquatic organisms are exposed in the natural waters.* *The NDEP's concern with the 2017 draft criteria is briefly addressed on pages 13-14 of the 1988 criteria document, which states, "…in some* ***cases these criteria would be overly protective when based on the total recoverable method*** *because the digestion procedure will probably dissolve some aluminum that is not toxic and cannot be converted to a toxic form under natural conditions.* ***This could be a major problem in ambient waters that contain suspended clay****." The NDEP agrees strongly with this latter sentence. As only a nod to this concern, the 2017 document simply notes that, "****Research on analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total***	The EPA clarified definitions of total recoverable aluminum in the 2018 criteria document. The 1988 AWQC for aluminum were discussed as acid-soluble concentrations and were subsequently expressed in terms of total recoverable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. Thus, if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document, the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of	Section 2.6.2

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	***recoverable aluminum concentrations**.” The last paragraph on page 22 summarizes the issue, but offers no resolution to the real problems created by using data from unfiltered samples. Acidifying an unfiltered sample is creating “acid mine drainage in a bottle.”* *The 2017 document seems to be making the same argument as discussed (and rejected) in EPA’s guidance from 1993. The argument being that, “if aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured…” (Section 2.6.2). The 2017 document reverses the consensus decision made in the 1993 guidance that use of data for dissolved metals is more appropriate. The NDEP agrees with the 1993 decision and notes that the **larger error** is in **overestimating** the amount of aluminum in solution by measuring all particulate aluminum collected in an unfiltered sample and subsequently dissolved under acidic conditions (pH 1.5 to 2). These dissolved species are unlikely to exist in the neutral-pH conditions found in the natural water, so use of “total” values is likely to overestimate the concentrations of the substantially more-toxic dissolved forms of aluminum.*	aluminum in natural waters. The comment that the report should provide the geographic distribution of total aluminum (rather than only dissolved, as in Figure 1 of the Draft Report) is not feasible. There is not a total aluminum figure available. The EPA disagrees with the comment, “Furthermore, the TSS levels are high enough that even with the proposed draft aluminum criteria based on the MLR, each of these rivers would still not meet water quality standards and would therefore need to be listed as impaired under Section 303(d) of the Clean Water Act.” The levels of TSS are not equivalent to the levels of DOC, which is used as an input parameter in the criteria calculator. Therefore, it is not possible to determine at this time if the rivers would be impaired.	
EPA-HQ-OW-2017-0260-0041 (John Heggeness and Mary A. Siders, Bureau of Water Quality Planning (BWQP), Nevada Division of Environmental Protection (NDEP))	*There may be a large difference in the concentration of metals measured in field-filtered versus unfiltered samples. Aluminum is the third-most abundant element in the Earth’s crust (Hem, 1992) and occurs in common alumino-silicate minerals such as clays. If the criteria are not intended to apply to alumino-silicate minerals that are suspended in an unfiltered sample, a sampling method that excludes such particulates is likely a better measure of the aluminum species that pose the greatest toxicity to aquatic life. Samples that are field-filtered **prior to acidification** provide the best estimate of the concentration of aluminum that is “dissolved” in a waterbody. (Again, we use the operational definition of “dissolved” as that portion that passes through a 0.45-µm membrane filter).* *Aside from ignoring solubility limits, another problem with using data from unfiltered samples is that it has the potential to introduce a large amount of variability and uncertainty to the analytical results for aluminum (and other metals). If one sample contains high concentrations of suspended solids, whereas other samples collected from the same site contains low concentrations*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	of suspended solids, the concentrations of "total metals" could be radically different depending on the amount of suspended solids each sample contained. Gibbons and Sara (1993) discussed the statistical problems introduced by using data from unfiltered samples, noting that, "Variability within wells is over five times as large for unfiltered versus filtered samples." (https://www.orau.org/ptp/PTP%20Library/library/EPA/samplings /gwwkshop.pdf). *The data presented show how unfiltered measurements can lead to increases in both false positive and false negative rates due to increased variability of the unfiltered results (i.e., false negative) and the relationship between concentration and sample turbidity that can be mistakenly interpreted as contamination (i.e., false positive)… It is clearly shown that unfiltered sample concentrations exhibit extreme variability, which is in large part due to sample turbidity and colloidal transport. Furthermore, even if a statistical adjust for the effects of turbidity was performed (i.e., in effect hold turbidity constant), differences between unfiltered and filtered metal concentrations still exist… These results clearly show that whether colloidal transport is real or not,* ***the price paid for using unfiltered samples is enormous****, both in terms of* ***missing real contamination when it exists*** *and in* ***detecting contamination when it is not present****."* *Although Gibbons and Sara (1993) were discussing groundwater data, the same concern of excessive variability in data from unfiltered samples applies here. The NDEP cannot be assured that use of such data is appropriate (let alone, workable, in the real world).* *From the perspective of aqueous geochemistry, the use of data from unfiltered samples will* ***not*** *provide representative or consistent results for any waterbody that contains suspended particulates. The use of aluminum salts (e.g., aluminum chloride, aluminum nitrate, aluminum sulfate) in controlled laboratory tests of toxicity does not consider the "real-world" conditions present in natural waters. It is understandable that one would want to control confounding variables, however, the laboratory tests ignore the contribution of aluminum (and other metals) from clays and particulates that would be dissolved by acidification of an unfiltered sample of stream or lake water. The proposed use of*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	"total" aluminum for criteria seems unlikely to be a workable approach for assessing toxicity of aluminum to aquatic organisms in natural waters.		
EPA-HQ-OW-2017-0260-0042 *(Bruce A. Stevens, President, Indiana Coal Council, Inc. (ICC))*	*The EPA has proposed the criteria as the total recoverable form of aluminum. Use of a total recoverable analysis measures both toxic and nontoxic forms of aluminum in the sample and is an overly-conservative method of applying the criteria. As stated in the Draft Criteria document, aluminum is an abundant element in the earth's crust. This includes the clays and silts that are easily entrained in runoff to streams and rivers following precipitation events. This is particularly true for Indiana, which is dominated by agricultural land use. Use of a total recoverable method will inherently measure the aluminum that is bound in these clays and silts, overestimating the actual toxicity of the water. This will subject NPDES permittees to potential for false-positives in their effluents, cause inaccurate 303(d) listings of streams, and lead to a waste of both state and industry resources. EPA should use an <u>alternative analytic method that only measures the aluminum that is biologically available to aquatic life</u>. It is ICC's preference that EPA instead use the dissolved form because of its already wide acceptance and use by laboratories, industries, and the scientific community.* *EPA should also include some discussion of how this alternative analytic method can be implemented into NPDES permits. Requiring permittees and states to translate all parameters to a total form for inclusion in an NPDES permit is the result of a dated regulatory requirement. These translator studies are often an unnecessary waste of resources on all parties involved. This needs to be brought in line with current scientific views on protection of aquatic life. EPA should include a reasonable alternative that allows application of the revised analytic method directly into NPDES permits.* *The EPA presents the Draft Criteria as a more scientifically valid approach and significant improvement over the current 1988 criteria. The EPA also argues that this is a significant relaxation of the 1988 criteria, which was set at 87 and 750 µg/L. However, the fact is that many states do not actively implement the 1988 criteria. One of the primary reasons for this is that the 1988 criteria was based on total aluminum. Again, this overestimates the actual toxicity and is impossible to implement at a statewide level because*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	of the permitting and assessment issues it creates. In order for EPA to tout any revised criteria as an "improvement", EPA must first address these primary issues.		
EPA-HQ-OW-2017-0260-0045 (Lee Lemke, Executive Vice President, Georgia Mining Association (GMA))	*The Georgia Mining Association (GMA) appreciates the opportunity to provide comment on the Draft Criteria published by the EPA in July 2017. We have carefully reviewed the document and agree that recent research findings on aluminum toxicity and chemistry warrant an update to EPA's 1988 recommended criteria for aluminum. However, we have significant concerns about the assumptions made and conclusions reached in the Draft Criteria. As a result, we urge EPA to revise the proposed Draft Criteria to recognize and accommodate the natural conditions of Georgia and the southeast, which include high levels of inert, biologically unavailable aluminum. In the Draft Criteria, EPA explicitly states:* *"… natural water samples may also contain other species of aluminum that are not biologically available (i.e., suspended particles, clays and aluminosilicate minerals) (Wilson 2012; Santore et al. 2017). This creates uncertainty because the total aluminum concentrations measured in natural waters may overestimate the potential risks of toxicity to aquatic organisms" (p.69, Draft Criteria)* *In addition, the biological literature establishes that kaolinite is inert and nontoxic to freshwater biota (e.g., Goldes et al. 1988; Tao et al. 1999; Tao et al. 2002; Beck et al. 2015). However, the Draft Criteria, which focuses on total aluminum, makes* ***no adjustment for forms of aluminum that are well understood to be biologically unavailable and nontoxic****. Accordingly, it is critical that EPA address the significant overestimation of the bioavailable aluminum resulting from its suggested analytical methods in the Draft Criteria.* *In these comments, we provide an overview of GMA and the mining industry in Georgia, describe the aluminosilicate mineral kaolinite, provide specific comments regarding the Draft Criteria with suggestions for revisions, and end with concluding remarks.*		
EPA-HQ-OW-2017-0260-0045 (Lee Lemke, Executive Vice President, Georgia Mining Association (GMA))	*Given these particular properties of kaolinite and its importance in Georgia and the southeastern United States, we respectfully submit the following comments on the Draft Criteria:* *1) The Draft Criteria requires measurement of total recoverable*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	aluminum, using analytical methods that involve the digestion of dissolved and suspended constituents in concentrated solutions of nitric acid and hydrochloric acid to pH < 2.0 (USEPA 1994 a, b). ***This method subjects aluminosilicate minerals to artificial conditions drastically divergent from any natural conditions*** *in order to disrupt the highly stable mineral bonds. However, the Draft Criteria specifically states that the recommended aluminum levels are intended to address toxicity to freshwater organisms in the pH range of 5.0 to 9.0 (p. xii and elsewhere). While the Draft Criteria emphasizes that total recoverable aluminum accounts for "colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available" (pg. 21),* ***this is not the case for kaolinite, which will not solubilize or become bioavailable in the applicable pH range of the Draft Criteria*** *(Dill 2016). As shown in Figure 2 below, strong acidic conditions (pH < 3) are required to solubilize aluminum ions from kaolinite's crystalline structure.* *Not only are the Draft Criteria not intended to address pH values low enough to dissolve kaolinite, but such conditions do not exist in natural settings, even those affected by acid rain and other extreme conditions (Malakoff 2010). Furthermore, because Georgia's Water Quality Standards prohibit the discharge of wastewaters outside of a circumneutral pH range (6.0-8.5), values sufficient to dissolve kaolinite should not exist in permitted discharges.* *Given the strong acid digestion that is a required part of the EPA's proposed methodology, the resultant values for total recoverable aluminum cannot distinguish between inert, lattice-bound aluminum such as kaolinite and bioavailable forms of aluminum. As a result, concentrations measured using this analytical method will drastically overestimate the amount of bioavailable aluminum in Georgia waters. The authors describe this reliance on total recoverable aluminum as a "conservative approach" (p. 21). However, the inclusion of aluminum forms* ***known to be biologically unavailable*** *is not conservative; rather it falsely characterizes as toxic a form of aluminum that is ubiquitous in Georgia and southeastern streams, and often at significant concentrations during rainfall and runoff events, even in undisturbed watersheds (Peters 2009).*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	As stated by Reviewer 2 in "EPA Response to External Peer Review Comments on the Draft Aquatic Life Ambient Water Quality Criteria for Aluminum" (hereafter "Review Comments"): *"The justification for the use of total recoverable aluminum is a complex topic which requires a decision to support the criteria development process" (p. 21).* *Thus, even the reviewers identified as questionable the application of a total recoverable aluminum approach in this application.*		
EPA-HQ-OW-2017-0260-0045 *(Lee Lemke, Executive Vice President, Georgia Mining Association (GMA))*	*The Reviewers' comments reflect concerns that the Draft Criteria would lead directly to unnecessarily burdensome regulations for all areas of the United States with naturally high levels of soil aluminum, particularly in the biologically unavailable form of aluminosilicate minerals (Figure 1). The overestimation of toxicity in the Draft Criteria's current methods is exacerbated by the MLR approach that lowers toxicity thresholds in the presence of low water hardness. In Georgia, and in many parts of the southeastern United States,* ***naturally low hardness paired with high background aluminum concentrations will likely result in pristine streams violating the EPA's Draft Criteria****. This scenario has the potential to drastically increase the number of 303(d) listings in the southeastern US as a direct result of "false-positive" exceedances of the criteria related specifically to the proposed methods. Such "collateral damage" is not acceptable as the unnecessary listings are not consistent with the intent of the Clean Water Act and would come at significant and burdensome costs to permittees and state and federal regulatory agencies, without any environmental benefits.* *Based on the comments above, GMA recommends the following:* *a) The EPA should explicitly exclude insoluble aluminum-bearing minerals such as kaolinite from the scope of the Draft Criteria.* *b) If the EPA has concerns that aluminosilicate minerals may pose toxicity threats, despite the abundance of data to the contrary, the EPA should conduct supplemental studies to explicitly address this prior to issuing final aluminum criteria. Allowance for site-specific criteria could be achieved using an approach similar to the Water-Effect Ratio that EPA has advocated for other metals (Davies, 1994).*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	c) The EPA should formally solicit reviewer responses to the issue of aluminosilicate minerals and the potential for overestimation of toxicity using total recoverable aluminum in regions where such minerals are abundant. The EPA must address the comments received in a reasonable, scientifically-based manner. *The EPA should consider convening experts for guidance on the issue of aluminosilicate minerals and the potential overestimation of toxicity using total recoverable aluminum. Such an approach was successfully used for assessment and review of the EPA's Aquatic Life Metals Criteria, during which a public meeting of experts was held in Annapolis, MD for development guidance (Prothro, 1993).* *d) If the EPA is unwilling to exclude aluminosilicates from the final criteria, the EPA must develop an additional method using a weak acid digestion procedure to achieve pH levels that more accurately represent natural stream conditions and the target pH range of the Draft Criteria (5.0-9.0). Such an approach could dissolve the potentially toxic complexes but not aluminosilicate minerals, thus avoiding the overestimation of bioavailable aluminum. (We note that the use of filtration methods to exclude kaolinite particles from a sample is not generally applicable due to the prevalence of extremely small particle sizes in naturally-occurring kaolinitic soils and geologic formations. As much as 50% of Georgia kaolinite particles are smaller than 0.45 µm in diameter (Conley 1966), which is the standard filter size used for dissolved metals analysis. Substantial quantities of particulate, non-bioavailable aluminum can pass through the filtration process and be quantified as dissolved aluminum, and incorrectly assumed to be bioavailable.) A precedent for a multi-faceted approach exists in the regulation of hazardous waste leachates. The Toxicity Characteristic Leaching Procedure (TCLP) (U.S. EPA 1992) is used for unnaturally low pH environments, such as those found in landfills. Alternatively, the Synthetic Precipitation Leaching Procedure (SPLP) (U.S. EPA 1994d) with higher pH methods is used to evaluate in-situ materials replicating natural rainfall exposure.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0047 (Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))	***Test Methods for Aluminum in Water** -- EPA notes in the draft criteria that natural waters contain mineral particulate forms of aluminum that are subject to measurement uncertainty when using "total recoverable" measurements of aluminum. This is a critical issue and further guidance from EPA is needed in managing this uncertainty in interpreting the toxicity data and applying aluminum criteria. The extrapolation of laboratory toxicity data for aluminum to regulatory criteria implementation in natural waters has long been problematic due to the complex chemistry of precipitated and solid phases of aluminum. The methods for total recoverable aluminum use a strong acid digestion resulting in an overestimation of the potential risks of toxicity to aquatic organisms due to the overly aggressive digestion procedure, which captures the mineral phases of aluminum that are normally non-bioavailable in the environment. This analytical procedure has resulted in numerous waters across the U.S. being listed as impaired for aluminum when in actuality the aluminum comes from the solids and is non-toxic. NAMC is concerned that absent further EPA explanation and guidance in this area, there will be numerous false positive outcomes in the implementation of the criteria generated because the total recoverable aluminum concentrations will exceed the criteria, whereas the true bioavailable concentration of aluminum would not exceed the criteria. Below, we provide further details on the magnitude of the issue of aluminum derived from suspended solids using a strong acid digestion, as well as our recommendation on an analytical approach to solve this issue. The multi-linear regression (MLR) approach is a step in the right direction and will alleviate some of the problems due to the fact that the criterion will go up for neutral and alkaline waters. Slightly acidic natural waters, which are high in suspended solids, however, will not be able to meet the new proposed criteria.*		
EPA-HQ-OW-2017-0260-0047 (Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))	*A review of data available in the United States Geological Survey (USGS) - National Water Information System (NWIS) for total aluminum, dissolved aluminum, and total suspended solids (TSS) to evaluate the relationships across U.S. waters shows little or no relationship between dissolved aluminum versus TSS. A strong relationship exists, however, between total aluminum and TSS based on 22,607 samples. (See Figure 1 below.) If one draws a line across the Figure at 87 µg/L, it is clear that more than 85% of the national surface waters would not be able to meet the current chronic water quality standard (87 µg/L). A standard of 400-500*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	µg/L would have to be adopted to achieve 50% compliance for the waters in this data set. Whichever standard value is considered, it is clear that the aluminum value is derived from the TSS and would not be bioavailable, since strong acid digestion was required to release the aluminum. *[Also presented are data for total aluminum versus TSS from five major U.S. rivers: Illinois, Mississippi, Missouri, Ohio, and Potomac Rivers (Figure 2). As shown, these five rivers cannot meet the current water quality standard of 87 µg/L. Furthermore, the TSS levels are high enough that even with the proposed draft aluminum criteria based on the MLR, each of these rivers would still not meet water quality standards and would therefore need to be listed as impaired under Section 303(d) of the Clean Water Act.* *These data clearly demonstrate the need for an analytical method that measures bioavailable aluminum, and not the aluminum contained in TSS. A manuscript outlining a method to measure bioavailable aluminum is in preparation, with the goal of establishing a modified method of analysis. In the interim, however, it would be extremely helpful if EPA reverted to the language in the 1988 aluminum criteria document, citing the acid-soluble method (EPA 1991; method 200.1) as the recommend method for implementation, which EPA has done in the past. This EPA action would accomplish three things: (1) it would take the emphasis off total recoverable aluminum; (2) it would open the door to a subsequent adoption of a modified version of this method using a less stringent extraction procedure designed to measure only bioavailable aluminum; and (3) it would reduce the likelihood of anti-degradation and/or anti-backsliding claims. Failure to do this will have significant implication for the States to adopt and implement the draft criteria approach.*		
EPA-HQ-OW-2017-0260-0047 *(Kathleen M. Roberts, Executive Director, North American Metals Council (NAMC))*	*NAMC believes a new analytical method is needed that measures only bioavailable aluminum. NAMC is aware that there is a method under development, which is a modification to the acid soluble test described in the existing EPA 1988 national aluminum criteria, that uses a pH 4.0 extraction method to obtain bioavailable aluminum fractions. The method is being prepared for publication and will be made available to EPA in the near future. We believe a more thorough discussion by EPA of the uncertainties regarding the use of total recoverable aluminum concentrations in natural waters and the possibilities offered by a modification to the*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	test method would help inform the ultimate implementation of the revised criteria and facilitate its implementation in the future.		
EPA-HQ-OW-2017-0260-0049 (Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)	*Our primary concern is that, if adopted in their current form, the proposed criteria may cause some state authorities to wrongly conclude that many waterbodies are "impaired" based on Total Aluminum concentrations measured in samples of stormwater runoff. This, in turn, will likely result in a large number of inappropriate 303(d) listings, unnecessary TMDLs, and inaccurate permit violations. The basis for our concern and our recommendations for avoiding this unintended outcome are described below.*		
EPA-HQ-OW-2017-0260-0049 (Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)	*The draft document acknowledges that aluminum is found in most rocks, clays, soils, and sediment, and that these natural sources are the dominant source for aluminum entering aquatic ecosystems. [DAC @ pg. 2] Specifically, the EPA cites authoritative sources stating that, due to its abundance in the earth's crust, soil concentrations of aluminum average approximately 71,000 mg/kg. [DAC @ pg. 6] This is critically important because storm water runoff contains naturally high concentrations of total suspended solids (TSS) such as clay soils and entrained sediment.*		
EPA-HQ-OW-2017-0260-0049 (Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)	*The proposed criteria is expressed as Total Aluminum. [DAC @ pg. xii] Total Aluminum is measured using an unfiltered sample and an acid digestion procedure that is intended to quantify at least 95% of the aluminum, including any suspended sediment, in the sample. [DAC @ pg. 3 & 4] The District's long-term water quality monitoring data indicates that the average TSS concentration in stormwater runoff is approximately 300 mg/L and is about ten times higher than normally seen in samples collected during dry weather conditions. Consequently, it is reasonable to expect that a random sample of stormwater runoff with 300 mg/L of TSS could contain more than 20,000 ug/L of Total Aluminum. Such concentrations are more than four times higher than the maximum estimated acute criteria (4,300 ug/L) and ten times higher than the maximum estimated chronic criteria (2,000 ug/L) described in draft criteria document and would constitute an "exceedance" were such criteria used to evaluate compliance with water quality standards. [DAC@ pg. K-5 (see Tables K-7 and K-8)]*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The draft document states that aluminum can become sorbed to clay particles or complexed to DOC and later be converted to reactive (toxic) form. [DAC@ pg. 3] The EPA explains that measuring only dissolved aluminum fails to consider such conversions and, as a result, would likely underestimate the potential for aquatic toxicity. [DAC @ pg. 22] Measuring Total Aluminum will account for the "colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available." [DAC @ pg. 22] However, by breaking the strong molecular bonds in the soil particle itself, the laboratory-based acid digestion procedure will also significantly overestimate the concentration of Total Aluminum that can become bioavailable under the natural stream conditions (e .g. pH 5 - 9) for which the proposed criteria were intended to apply.*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*4. While toxic species of aluminum may sorb to soil particles, the draft document explicitly acknowledges that particles themselves contain species of aluminum that are not biologically available. [DAC@ pg. 6] In natural soils, aluminum is molecularly bound with silica, oxygen, and other minerals to form inert and insoluble molecules. These mineral molecules have a very low Product Solubility Coefficient (i.e. Ksp<0.01 mol/L) and cannot be dissolved by freshwater in the range of pH commonly found in the natural environment. A strong acid (pH<3) is required to break such bonds and convert any aluminum in the soil particle itself to a more bioavailable and toxic form. The laboratory procedure used to measure Total Aluminum does precisely that by using nitric acid (pH≈2) to "digest" the sample. This laboratory procedure not only releases all of the aluminum "sorbed" to the soil particle, it also dissolves all of the aluminum in the soil particle. As such, the laboratory digestion procedure creates a condition that does not occur naturally and greatly overestimates the potential for aquatic toxicity by assuming all of the aluminum that is safely bound within such particles "might" become bioavailable. Outside of exposure to acid mine drainage, it is difficult to imagine how such extreme pH conditions could occur naturally. This is particularly true in the arid southwest where soils have more pH buffering capacity than is typically seen in the eastern U.S. [DAC@ pg. 9]*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*All of the studies that the EPA evaluated to develop the recommended criteria relied solely on toxicity data from laboratory studies using soluble aluminum salt compounds (e.g., aluminum chloride, aluminum nitrate, and aluminum sulfate). [DAC @ pg. 20] These man-made compounds are designed to dissolve in water and convert the aluminum to a highly-bioavailable form (see Table 1 below). This is reasonable as one must start with a toxic form of aluminum in order to evaluate how pH, hardness, and DOC affect that toxicity. However, the chemical behavior of these soluble salts is <u>not representative or predictive</u> of how insoluble aluminum-bearing minerals react when exposed to water with a relatively neutral pH. By expressing the proposed water quality criteria as Total Aluminum, the EPA has ignored this important distinction and improperly assumed that the aluminum found in common granitic soils is as likely to become toxic under natural conditions as the aluminum in soluble salts. The External Peer Reviewers expressly warned the EPA against making or applying such simplistic assumptions. [EPA Response to External Peer Review Comments. July, 2017 (see Reviewer #4@ pgs. 41 & 43).]* *[Table 1]*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The draft document states that pH, hardness and DOC "are thought to be the most influential for aluminum bioavailability and can be used to explain the magnitude of differences in the observed toxicity values." [DAC@ pg. 21] In fact, it also acknowledges that the specific mineral form of aluminum is another significant factor. However, the EPA warns that: "although many factors might affect the results of toxicity tests of aluminum to aquatic organisms, water quality criteria can quantitatively take into account only factors for which enough data are available to show that the factor similarly affects the result of tests with a variety of species." [DAC@ pg. 27] The problem with this approach is that laboratories deliberately choose to use only soluble salt compounds to evaluate the potential toxicity of aluminum. Commonly occurring insoluble mineral compounds with high concentrations of Total Aluminum (e.g., kaolinite, feldspar, gibbsite, bauxite, etc.) are never tested because there is no expectation that these compounds can or will become toxic in water. Nevertheless, the EPA relies on the absence of such studies to support the proposition that there isn't enough data to make appropriate adjustments to account for aluminum solubility in the*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	proposed aluminum criteria. In this instance, the absence of data is conclusive evidence of the existing scientific consensus that some insoluble forms of Total Aluminum are not and cannot cause toxicity under natural conditions.		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The EPA describes its decision to propose a Total Aluminum criteria as "conservative" because it includes all forms of aluminum. [DAC @ pg. 21] While such an approach might be considered appropriate when dealing with soluble aluminum salts or colloidal aluminum sorbed to insoluble mineral particles, it grossly misrepresents the ecological risk posed by the particles themselves. Measuring the total recoverable aluminum concentration present when exposing test organisms to soluble salts is not a reasonable proxy for estimating the potential bioavailability of insoluble mineral compounds. Deliberately selecting an approach that severely over-estimates the potential for toxicity is no more accurate or acceptable than one that under-estimates it. The External Peer Reviewers warn that the "document is written as if aluminum is like other metal contaminants and aluminum is very different." The External Peer Reviewers go on to recommend that the EPA revise the document to consider aluminum solubility (Ksp) and recognize solid speciation. [EPA Response to External Peer Review Comments. July, 2017 (see Reviewer #4@ pg. 41)] However, the EPA ignored this recommendation and made no substantive changes to the proposed water quality criteria despite conceding that: "research on analytical methods is on-going to address concerns with aluminum bound to particulate matter (i.e. clay) from natural waters being included in the total recoverable aluminum concentrations." [DAC @ pg. 21] The lack of proper analytical methods to adequately distinguish between bioavailable and non-bioavailable forms of aluminum does not justify continued reliance on a false assumption that all forms of aluminum share an equal potential to cause aquatic toxicity.*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*As presently written, it would be easy for readers who are not well trained in the nuances of aluminum chemistry to misunderstand exactly what the EPA means when it says that: "aluminum sorbed to clay particles or complexed to DOC and later be converted to reactive form" or that "colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available." [DAC @ pg. 22] Therefore, the EPA should explicitly state that while the colloidal aluminum and hydroxide precipitates bound to clay particles may become*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	bioavailable, the aluminum that is molecularly-bound within such particles cannot become toxic under natural conditions and the final criteria is not intended to apply to natural aluminum-bearing minerals with very low Ksp values.		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The Total Aluminum criteria should not apply to natural mineral soils until well-controlled laboratory experiments have been conducted to confirm the presence of a valid dose-response relationship for these insoluble forms of aluminum. [DAC@ pg. 21 (referencing Gensemer et al, 2017).] The EPA took great care to avoid predicting the potential toxicity of aluminum outside the range of hardness (<150 mg/L) and DOC (<5 mg/L) that had been evaluated in well-designed laboratory experiments. For the same reason, the EPA should avoid extrapolating outside the range of aluminum solubility that has been tested and caution others against doing so as well.*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The final criteria should state, explicitly, that the standard acid-digestion method will overestimate the amount of Total Aluminum that is likely to become bioavailable or toxic if the sample also is contaminated by the presence of natural soils and sediments (i.e., measurable TSS).*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The final criteria should describe other analytical procedures that are presently available (such as the weak-acid digestion method) to estimate the concentration of Total Aluminum that is sorbed to clay particles without also including the concentration of aluminum within the insoluble particles themselves.*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The final criteria should describe and endorse the techniques some states (e.g., New Mexico) use to minimize the risk of over-estimating the concentration of bioavailable aluminum by analyzing parallel samples that have been passed through a course filter to reduce TSS associated with stormwater runoff.*		
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The EPA should advise states that when high concentrations of Total Aluminum appear to be closely associated with elevated TSS levels in a given sample, it may be appropriate to employ the EPA's methods for evaluating sediment-based toxicity to assess the true potential for that aluminum to become bioavailable.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0050 *(J. Tyler White, President, Kentucky Coal Association (KCA))*	*The Draft Criteria is based on the total form of Aluminum. This will result in an overstatement of the toxic fraction of aluminum in samples of discharges from the mining industry and other industries where discharges are induced primarily by precipitation and snowmelt and therefore contain high suspended sediment loading. (In many cases, the high sediment loading will not be caused by the mining discharger; for example, in west Kentucky, areas in the vicinity of mining are highly agricultural such that sediment in mining discharges is largely caused by the use of surrounding surface areas for farming). In light of the potential for the total recoverable method to inaccurately reflect the toxic form of aluminum, EPA should adopt an alternative form of aluminum as the basis for the criteria. Because the Draft Criteria do not take this issue into account, EPA should re-propose any draft criteria (should it choose to proceed) with an adequate explanation and justification for its selected form of aluminum.*	The EPA disagrees with West Virginia Coal Association (WVCA)'s assertion that it has taken a huge step backward with the 2017 Draft Aluminum Criteria and that any remote improvement made by the multiple linear regression (MLR) approach is entirely subsumed by an inappropriate analytical method that will grossly overestimate aluminum toxicity in most waters. The approach for the draft and final aluminum criteria makes use of the best available science. In addition, in the final aluminum criteria document, a new bioavailable aluminum method is discussed and has been recently published (see citation above). The EPA disagrees with the West Virginia Coal Association's assertion that US EPA intends to force States to adopt the Draft Aluminum Criteria soon after they become final. Aluminum is not a priority pollutant, and therefore states are not required to adopt the recommended criteria. The EPA disagrees with the West Virginia Coal Association's assertion "If implemented, the impacts of the total recoverable Draft Aluminum Criteria on individual States will be devastating. Many healthy streams will be listed as impaired. We will slide backward many years, all in the guise of 'better science.'" In fact, in the majority of waters of the US, aluminum criteria are expected to increase in magnitude. In response to *Pennsylvania Department of Environmental Protection (DEP)'s comment,* the 1993 memo entitled "Additional Material for the Water Quality Handbook" was not a guideline but a policy guidance memo. The memo did not include aluminum. In fact, the 1988 aluminum criteria were discussed as acid soluble aluminum but were subsequently expressed as total aluminum and not dissolved.	
EPA-HQ-OW-2017-0260-0053 *(Abdul Alkhatib, Director, Massachusetts Water Works Association (MWWA))*	*I am a member of both the Massachusetts Water Works Association (MWWA) and the New England Water Works Association (NEWWA) and I would like to echo the comments made by the association relative to the United States Environmental Protection Agency's (EPA) proposed Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater published in the Federal Register on July 28, 2017 (Docket ID No. EPA-HQ-OW-2017-0260).* *I am pleased to see that EPA is updating the national freshwater aquatic life ambient water quality criteria to take into account water quality parameters that affect Aluminum toxicity and bioavailability. The current Aluminum criteria, adopted by EPA in 1988, does not appear to be appropriate for receiving waters in the New England region. Many of the receiving waters in New England, including many high quality, pristine waterways, already have natural background levels of Aluminum that exceed the current national water quality standard that is used as the basis for numeric permit limits. The high levels of background Aluminum in waters generally considered to be very clean suggest that the current standard is grossly inaccurate and unnecessarily overprotective.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0057 *(Roger Claff, P.E., Senior Scientific Advisor, American Petroleum Institute (API))*	*The use of total aluminum raises the possibility of misinterpreting and overstating toxicity potential in water bodies that receive high aluminum loadings in the form of aluminosilicate and other tightly-bound, non-bioavailable particles, such as in storm water. As previously stated, the use of a method that results in false positive impairments and a need to determine site-specific criteria results in wasted resources and diverts from addressing water bodies that are truly at risk. Implementation guidance including a differential analysis between particulate-bound but acid-extractable, and otherwise acid-extractable, aluminum is needed. The differential analysis must be validated to show it represents the bioavailable fraction of aluminum. EPA acknowledges this deficiency in two locations in the draft guidance but does not indicate how it might be approached to ensure unreasonably stringent criteria are not implemented in these water bodies.*		
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	***<u>EPA should base the criteria on acid-soluble aluminum, which is the toxic form of aluminum to aquatic life.</u>*** *EPA proposes to base the updated criteria on total recoverable aluminum as compared to the 1988 criteria that was based on acid-soluble aluminum. EPA believed basing the 1988 criteria on the acid-soluble aluminum would account for all toxic forms of aluminum, while not including the non-toxic forms such as "aluminum occluded in minerals, clays, and sands or strongly sorbed to particulate matter." Id. at 11. Basing the new standard on total or total recoverable aluminum as compared to acid-soluble aluminum is inconsistent with what is known about the toxicity of aluminum. EPA's discussion on page 21 of the Draft Criterion does not refute that as it is focused on test results comparing the "dissolved" and "total recoverable" aluminum in the samples, not the "acid-soluble" aluminum.* *In supporting the move away from acid-soluble aluminum to total recoverable aluminum for the criteria, EPA appears to equate acid-soluble aluminum with both dissolved aluminum (see Draft Criteria at xii) and total recoverable aluminum (id. at 20-21) [Although EPA acknowledges that the 1988 criteria is based on acid-soluble aluminum, it goes on to suggest that it is synonymous with total recoverable aluminum as the criteria came to be expressed in that form, probably because of the approved test method. Draft Criteria at 21.] But acid-soluble aluminum is not the same as either dissolved aluminum or total recoverable aluminum. Acid soluble aluminum is "defined as the aluminum that passes*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	through a 0.45 µm membrane filter after the sample has been acidified to a pH between 1.5 and 2.0 with nitric acid." 1988 Criteria at 10-11. While dissolved aluminum is filtered, it is not acidified before being filtered. And unlike total recoverable aluminum measurement, acid-soluble aluminum measurement does not require digestion. It is that digestion step of the approved Part 136 analytical method for total recoverable aluminum that solubilizes the non-toxic forms of aluminum (e.g., aluminum bound to clays). *UWAG acknowledges the benefit of expressing the criteria as total (i.e., total recoverable) aluminum since the aqueous chemistry of this element is complex and there are no EPA-approved methods to measure the various species of aluminum. Expressing the criteria in the total form allows ease in terms of monitoring, reporting, and calculating WQBELs, where these are necessary. However, there must be a translator to address that not all of the total recoverable aluminum is in fact toxic. Otherwise, the resulting criteria will be unnecessarily over-protective with no measureable benefit for the additional treatment cost. EPA concedes this in acknowledging the need to develop a method that will "address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations." Draft Criteria at 21. That is exactly what measuring the acid-soluble fraction as described in the 1988 Criteria is designed to do. Additionally, UWAG requests that EPA express the criteria as **total recoverable concentrations**, not simply total, though the Agency appears to use the terms synonymously in the Draft Criteria.*		
EPA-HQ-OW-2017-0260-0062 *(John St. Clair, Rosebud Mining Company)*	*The Criteria for Aluminum stresses the dependence of the bioavailability of aluminum to living organisms based on the chemical properties of water. Dissolved aluminum is bioavailable and toxic to aquatic life, yet the proposed recommended levels of aluminum are based on total aluminum. In often cases, total aluminum can also measure suspended clay sediment which is not toxic to aquatic life as long as suspended solids limits are applied. This can be seen in mine drainage from active underground coal mines that typically contain suspended clay sediment associated with the underclays of coal seams. While the water may contain elevated aluminum levels, the aluminum is bound to other elements of the clay particles and is not bioavailable to aquatic life. Therefore, the chronic and acute criterion should be based on*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	dissolved aluminum concentrations and not total aluminum concentrations.		
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*West Virginia is perhaps unique among the states in its long and detailed history with US EPA's national recommended water quality criteria for aluminum. We are also likely unique in the fact that we have access to individuals who have been involved in this process since its beginning in the State, and therefore we have substantial institutional knowledge of the issues and history associated with implementation of the 1988 Criteria in West Virginia.* *In 1993, West Virginia adopted the 1988 Criteria into its water quality standards. At that time, West Virginia and Delaware were the only two States to adopt the 1988 Criteria. Soon thereafter, the West Virginia Department of Environmental Protection (WV DEP) noticed a disturbing trend - many water bodies would be considered impaired for aluminum based on the new aluminum criteria. In 1996, WV DEP asked the West Virginia Environmental Quality Board (EQB) to reevaluate the aluminum criteria based on data available in STORET for 1990 to 1996:* • *87.6% of WV streams samples violated the chronic aluminum criterion.* • *28.5% of WV stream samples violated acute aluminum criterion.* *WV DEP expressed its belief that these exceedances were not linked to aquatic life impairment and promised to study this issue. Because of this, West Virginia began the reassessment of the 1988 Criteria almost immediately after their adoption by the State.* *During the 1997 triennial review, West Virginia deleted the chronic aluminum criterion based on the questionable scientific validity of the two studies used to lower the chronic criterion to 87 µg/l. In 1999, US EPA disapproved the deletion, stating that "West Virginia has not provided EPA with a scientific rationale to support the removal of the aquatic life chronic criterion for aluminum." US EPA provided two options: (1) adopt the EPA recommended chronic criterion of 87 µg/l, or (2) adopt a scientifically defensible alternate chronic criterion. After multiple iterations over ten years, West Virginia adopted the following dissolved aluminum criteria:*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	[Table] *This provided substantial relief to WV DEP for stream impairment and assessment determinations. However, because the criteria are implemented based on total recoverable concentrations for permitting purposes, many NPDES permittees have struggled to comply with water quality-based effluent limits (WQBELs) for aluminum, especially for precipitation-induced discharges. The problem is not associated with high turbidity; the majority of samples collected by permittees have concentrations of total suspended solids at or below the detection limit.* *In 2013, West Virginia adopted hardness-based aluminum criteria, virtually identical to those adopted in New Mexico and Colorado and approved by US EPA. In 2016, West Virginia revised the hardness-based criteria based on US EPA comments, and still US EPA has refused to approve the criteria revision, informally citing its own efforts to develop revised national recommended aluminum criteria.* *Roughly half of the States have adopted some form of aluminum criteria. Less than ten States have adopted the 1988 chronic criterion of 87 µg/l as a total aluminum concentration for all waters. Pennsylvania explicitly rejected the chronic aluminum criterion, citing the same bad science that West Virginia referenced in 1997. US EPA Region 3 approved Pennsylvania's aluminum criteria in 2001, even though the agency initially rejected a proposal from West Virginia to adopt the same standards. In collecting data for stream impairment determinations, Pennsylvania utilizes a 0.1 um filter instead of a 0.45 um filter prior to analysis to ensure that small particles are not captured in stream where acid deposition is suspected. Likewise, US EPA has approved Pennsylvania's 303(d} list of impaired waters.* *Clearly, many States are aware of the issues associated with the 1988 Criteria and have rejected the adoption of aluminum criteria entirely. Instead of addressing these concerns, US EPA has taken a huge step backward with the use of total recoverable aluminum for the 2017 Draft Aluminum Criteria. Any remote improvement made by the multiple linear regression (MLR) approach is entirely*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	subsumed by an inappropriate analytical method that will grossly overestimate aluminum toxicity in most waters. *We are keenly aware that US EPA intends to force States to adopt the Draft Aluminum Criteria soon after they become final.* ***<u>US EPA Region 3 has held West Virginia's hardness-based aluminum criteria hostage tor years, reciting the legally infirm excuse that it was developing a federal Draft Aluminum Criteria</u>****. US EPA has explicitly informed Oregon that it will enforce the Draft Aluminum Criteria once finalized:* *"EPA intends to propose freshwater acute and chronic criteria for aluminum in Oregon in a separate rulemaking at a later date following completion of updates to EPA's CWA section 304(a) recommended criteria for aluminum."* *(81 Fed. Reg. 22555, April 18, 2016). If implemented, the impacts of the total recoverable Draft Aluminum Criteria on individual States will be devastating. Many healthy streams will be listed as impaired. We will slide backward many years, all in the guise of "better science."*		
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*US EPA presents a somewhat lengthy discussion of the occurrence and abundance of aluminum in the environment. US EPA acknowledges that aluminum is the most abundant metal in the Earth's crust. The discussion includes a review of the range of concentrations in rocks, soils, surface waters, and groundwater. The document addresses the solubility of aluminum hydroxide species across pH ranges.* *More than 98% of the Earth's crust consists of oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium. How then, are we to keep aluminum almost entirely out of surface waters? And how are we to believe that this most abundant metal is so acutely and chronically toxic to aquatic life? The upper range of aluminum in soils is over 100,000 mg/kg. (US EPA Draft Aluminum Criteria, p. 6.) Anyone who has seen a stream after a storm knows that soils and other weathered geologic materials enter our waters regardless of human activity. It is counterintuitive to assume otherwise.* *Much of the aluminum in natural waters is in the form of weathered soils and rocks and is not bioavailable. This issue is*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	recognized in one of the primary studies cited in US EPA's Draft Aluminum Criteria: *"Even though precipitated forms of Al contributed to toxicity in the present laboratory studies, the forms of Al generated in laboratory waters (Al(OH)3) are not the same as well-aged and mineral forms of solid phase Al in natural waters (e.g., Al-silicates) as measured in total suspended solid measurements. In these cases total "recoverable" Al assays will overestimate exposure concentrations to aquatic organisms in natural waters owing to the strong acid digestion steps used by the analytical method.* ***As a result, steps should be taken to minimize measuring forms of Al in natural waters that do not contribute significantly to Al toxicity****." (Gensemer et al., 2017; internal citations omitted, emphasis added.) This comment is echoed in the literature publishing the MLR adopted by US EPA:* *"Lastly, it is critical to note that although the Al toxicity data used to develop the MLR models and HC5s described in this evaluation are based on total Al concentrations in laboratory waters,* ***it is inappropriate to analyze total Al concentrations in natural waters for comparison****. This is because many natural waters contain Al in mineral forms, such as clays and other suspended particles, which are non-bioavailable" (DeForest et al., 2017; internal citations omitted, emphasis added.) The reason for this is simple- laboratory toxicity tests are conducted with test solutions of highly soluble simple salts (most often aluminum chloride and aluminum sulfate) rather than aluminum from natural geological materials.* ***US EPA must resolve this disparity before proceeding with revised aluminum criteria****.*		
EPA-HQ-OW-2017-0260-0065 (Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))	*US EPA speaks of its review of extensive water quality data for aluminum. Ironically, the total number of surface water samples evaluated by US EPA in its discussion (4,991 samples for dissolved aluminum and 2,492 samples for total aluminum collected over sixteen years) is less than the number of aluminum samples collected by NPDES permittees in West Virginia in a single month. In the course of its 15 plus year experience with developing its state-specific aluminum standards, West Virginia has surveyed thousands of streams and collected hundreds of thousands of samples.* *The West Virginia coal industry has extensive firsthand experience*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	with aluminum water quality data. We can state without hesitation that the aquatic environment faces more risk from treating surface waters with flocculants and coagulants to meet stringent water quality-based effluent limits (WQBELs) for aluminum than could have ever possibly been caused by the original aluminum in the effluent. *In West Virginia, aluminum is largely occluded in clays. In fact, the dissolved aluminum observed in many surface water samples could likely be eliminated if a better filter were utilized. If we were to adopt Pennsylvania's use of a 0.1 µm filter prior to analysis, we anticipate that dissolved aluminum would be below the detection limits for most samples.* *Moreover, these natural forms of aluminum have no potential to become soluble due to the slight changes in pH experienced in most surface waters. The US EPA Draft Aluminum Criteria would have readers to believe that surface waters have dramatic changes in pH over short periods of time. This may be true for streams affected by acid deposition. However, most streams have very little variability in pH, including those with low pH due to historic acid mine drainage. The pH in most surface waters does not swing dramatically, increasing and decreasing aluminum solubility. Once again, WVCA members collect thousands of surface water samples each month. We are highly familiar with the pH in waters of the State.* *<u>Remarkably, US EPA seems entirely disinterested in the actual chemistry of aluminum in the environment.</u> The toxicity tests utilized in the Draft Aluminum Criteria utilize the most soluble - and therefore most bioavailable - forms of aluminum. It does not matter that these forms of aluminum are not likely to be encountered in most surface waters.[Ironically, none of the three States with bauxite mining (Arkansas, Alabama, and Georgia) have adopted aluminum criteria, and apparently US EPA has been disinterested in requiring aluminum criteria in the States where aluminum oxides might enter the waters. Instead, US EPA has delayed consideration of hardness-based aluminum criteria in West Virginia for years to "protect" our State waters from insoluble aluminum in clay particles.] Again, before proceeding with the Draft Aluminum Criteria, US EPA must resolve this disconnect. Otherwise, countless healthy streams will be listed for*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	impairment and needlessly scheduled for TMDL development. [This, of course, assumes that US EPA plans to treat all States equally and unilaterally impose the requirement to adopt the revised national criteria for aluminum.]		
EPA-HQ-OW-2017-0260-0066 (David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)	*Expression of the aluminum criteria as acid-soluble aluminum and not total recoverable aluminum. Species that are not acid-soluble are not known to have toxic effects on aquatic life per EPA's past practice in developing the criteria.*		
EPA-HQ-OW-2017-0260-0067 (Patrick McDonnell, Secretary, Pennsylvania Department of Environmental Protection (DEP))	*DEP has concerns regarding the use of a "total" rather than "dissolved" standard for aluminum and the resulting impairment issues raised with spikes in total aluminum concentrations caused by soil-laden samples that are often collected after storm events. Additionally, we would like to comment that instead of using "hardness" in its criteria, EPA consider using calcium concentration, in the hopes of correlating more precisely with the element of hardness which may be responsible for its protective effect on the metal toxicity.*		
EPA-HQ-OW-2017-0260-0067 (Patrick McDonnell, Secretary, Pennsylvania Department of Environmental Protection (DEP))	*Analyzing samples for non-dissolved aluminum requires collection of unfiltered samples, which, depending on how recently precipitation has occurred, may contain significantly varying quantities of suspended soil. Such soil-laden samples are then subjected to "digestion" per EPA method 200.7, which has been shown to extract aluminum from clays (See the 2016 work of He and Ziemkiewicz and the references cited therein). [Y. Thomas He and Paul F. Ziemkiewicz, "Bias in Determining Aluminum Concentrations: Comparison of Digestion Methods and Implications on Al Management," Chemosphere 159 (September 2016): 570-76, doi: 10.1016/j. chemosphere.2016.06.052] Our scientists are observing surges in total aluminum to values above the EPA's impairment threshold after rain-related events where large amounts of earth are stirred up into the water column. However, such high flow events do not coincide with the adverse effects to stream biology that would be expected with toxic metals concentrations. This supports the theory that the sampling and extraction methods result in the reporting of aluminum fractions that are not readily bioavailable; over-representing the bioavailable fraction of aluminum in the sample.* *Considering the forgoing, if the EPA's "total aluminum" criteria*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	are adopted, the states would be required to list a stream as "impaired" if the total aluminum exceeds the standard during these high flow events, with soil-laden waters, which is an artifact of the analytical methods rather than related to the true risk of exposure to bioavailable aluminum.		
EPA-HQ-OW-2017-0260-0068 *(Rachel Gleason, Executive Director, Pennsylvania Coal Alliance (PCA))*	*Because the criteria are implemented based on total recoverable concentrations for permitting purposes, many NPDES permittees have struggled to comply with water quality-based effluent limits (WQBELs) for aluminum, especially for precipitation-induced discharges. The problem is not associated with high turbidity; the majority of samples collected by permittees have concentrations of total suspended solids at or below the detection limit.* *Often, aluminum in Pennsylvania mine water is associated with the underclays of a coal seam where it is largely occluded, is not dissolved but is a suspended sediment, and is not toxic to aquatic life. However, total recoverable aluminum includes both the suspended sediment form of aluminum and the dissolved form of aluminum, resulting in a misrepresentation of water toxicity. For example, Pennsylvania mine water may measure aluminum of 0.75 mg/L, but have total suspended solids under 35 mg/L, which is not harmful to aquatic life.* • *Therefore, we request that US EPA review the use of dissolved aluminum in the criteria and in lieu of total aluminum.* • *We also stress that is important that individual states retain their ability to utilize translator studies to evaluate the impact of dissolved aluminum to instream water. US EPA should include a statement within the recommended criteria stating that translator studies are allowed and that the associated limits be adjusted accordingly.*		
EPA-HQ-OW-2017-0260-0069 *(Julia Young, Water Quality Standards Coordinator, Kansas Department of Health and Environment (KDHE))*	*Total aluminum could overestimate the toxic levels particularly after high flow events that contain high levels of sediment. The draft criteria identifies that many of these sediments contain aluminum in their structure, which will be measured using the total or total recoverable analytic methods. Runoff from fields will contain significant amounts of clay and silts that will cause exceedance of aluminum in the water due to sediments, but much of the aluminum is not bioavailable. When such samples from transient runoff conditions are analyzed they could present levels of aluminum that exceed EPA criteria limits that could lead to overestimations in the actual levels of aluminum present in water.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	In fact, because aluminum is ubiquitous in Kansas soils, KDHE utilizes "total recoverable aluminum" to characterize if a stream sample is from a base flow or runoff condition. During runoff, metals concentrations can be elevated, but tightly bound to the sediment and not reactive biologically. In the absence of actual measured flow data, KDHE has determined there is a high probability that runoff was occurring during sampling if the aluminum concentration 1 mg/L or greater.		
EPA-HQ-OW-2017-0260-0071 (Fredric P. Andes, Coordinator, Federal Water Quality Coalition (FWQC))	*USE OF TOTAL RECOVERABLE ALUMINUM FORM: The Draft Criteria are expressed as total recoverable aluminum. That is a substantial change from EPA's past practice, which was to use the acid-soluble aluminum form. We believe that using total values disregards what we know about aluminum toxicity, and results in regulation of aluminum presence that has no effect on aquatic life. Instead, EPA should express the criteria as acid-soluble aluminum. The Agency should also allow States to use the dissolved form instead, with site-specific dissolved-particulate studies to determine the appropriate permit limits.*		
EPA-HQ-OW-2017-0260-0072 (Paul Bedore, M.S., Senior Scientist, Robertson-Bryan, Inc. (RBI on behalf of Port of Stockton, San Joaquin County, California)	*We appreciate the opportunity to provide comments on the report "Draft Aquatic Life Ambient Water Quality Criteria for Aluminum 2017" (hereinafter "Draft Report") and the draft aluminum criteria provided therein (USEPA, 2017a). Our firm, Robertson-Bryan, Inc. (RBI), has been instrumental in the development and adoption of refined water quality objectives in the Central Valley of California. RBI has developed technical reports with supporting scientific literature and data to support the rule process of refining water quality objectives, considering all beneficial uses of the water body, and has developed site-specific and refined region-wide objectives for temperature, pH, and turbidity, and site-specific objectives for trihalomethane compounds, that have been adopted by California's state and regional water boards and approved by USEPA. Comments provided herein on the Draft Report were prepared on behalf of the Port of Stockton (Port), a Phase 1 Municipal Separate Storm Sewer System (MS4) located in San Joaquin County, California. The Port's MS4 discharges into the lower segment of the San Joaquin River, which drains a watershed of approximately 15,600 square miles.* *Comments provided herein address the need for the Draft Report to evaluate and account for non-bioavailable aluminum species, since such species are common in aquatic environments. This issue*		

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<tr><th>Comment Number (Organization)</th><th>Public Comment on Topic 19: Regarding implementation issues with measuring aluminum</th><th>EPA Response</th><th>Revision Location in 2018 Aluminum Criteria Document</th></tr>
<tr><td></td><td>is of particular relevance to the Port because the San Joaquin River, and presumably many other waterways throughout the nation, is seasonally affected by high wet season rainfall that washes particulate aluminum species from watershed soils into the river. Particulate aluminum mobilized from terrestrial sources is largely composed of recalcitrant forms of aluminum that are not bioavailable. If adopted as is, monitoring for compliance with the draft aluminum criteria using the total recoverable aluminum methodology will measure all forms of aluminum in a sample – bioavailable and non-bioavailable, dissolved and particulate – and thus will provide an indication that aluminum levels in the San Joaquin River seasonally exceed the draft aluminum criteria. Yet the aluminum species responsible for the exceedance (soil- and geologically derived aluminum particulates) are not bioavailable, and do not warrant considering aquatic life beneficial uses of the San Joaquin River as impaired with regards to aluminum. Accounting for the prevalence, yet lack of bioavailability, of particulate aluminum species (largely aluminosilicate minerals), will avoid unintended regulatory consequences, such as unnecessarily listing waterways on the federal Clean Water Act Section 303(d) list that requires the development of a control program to address the designated impairment.</td><td></td><td></td></tr>
<tr><td>EPA-HQ-OW-2017-0260-0072
(Paul Bedore, M.S., Senior Scientist, Robertson-Bryan, Inc. (RBI on behalf of Port of Stockton, San Joaquin County, California)</td><td><u>Comment 1. The particulate fraction of natural water samples overwhelmingly consists of aluminum-bearing silicate minerals (i.e., aluminosilicates), and greater discussion and evaluation of this form of aluminum in the Draft Report is warranted due to their pervasiveness.</u>

Section 2.6.2 of the Draft Report states that the appropriate analytical technique for assessing compliance with the draft aluminum criteria is total recoverable aluminum. This conclusion was made on the basis that the toxicity of a sample would likely be underestimated were dissolved aluminum used to assess compliance, since colloidal forms and hydroxide precipitates of aluminum can dissolve under certain conditions and become bioavailable. Measurement of total recoverable aluminum will quantify both particulate and dissolved aluminum species in a water sample, including mineral forms of aluminum such as aluminum oxide/hydroxides and aluminosilicates. The Draft Report indicates in Section 2.6.2 that "Applying the aluminum criteria to total recoverable aluminum may be considered conservative because it includes monomeric (both organic and</td><td></td><td></td></tr>
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Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	inorganic) forms, polymeric and colloidal forms, as well as particulate forms and aluminum sorbed to clays (Wilson 2012). Research on analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations." *As discussed in Filella (2007) and the references cited therein, of all colloids and particulates in natural water systems, the most abundant by far are aluminum-bearing silicate minerals (i.e., aluminosilicates), which are released most commonly to the aquatic environment via detachment from soil surfaces. It is not that aluminum is adsorbed to clay particles, as commonly noted in the Draft Report; rather, clay particles overwhelming consist of aluminum-bearing silicate minerals. In fact, the physical process of rainfall impact on soil surfaces is responsible for extensive dispersion of colloids and particulates, largely aluminosilicate species (Filella, 2007). Aluminosilicates are also the most abundant colloidal particles released into groundwaters (Filella, 2007). Thus, water samples with a substantial fraction of particulate aluminum relative to dissolved species are likely to be dominated by aluminosilicates, making these one of the most environmentally relevant aluminum species in the aquatic environment.* *Because the most prevalent aluminum particulate species in the aquatic environment are aluminosilicates, the Draft Report should evaluate and communicate in detail the minerology and chemistry of aluminosilicates, their overwhelming prevalence in the particulate fraction of natural aquatic environments, and their fate and transport from terrestrial sources to and within surface waters. The report should provide the geographic distribution of total aluminum (rather than only dissolved, as in Figure 1 of the Draft Report). Also, since aluminosilicates dominate the particulate aluminum fraction of natural waters, the Draft Report should evaluate in greater detail studies that report both particulate and dissolve aluminum concentrations in the aquatic environment and this information could be used to evaluate the degree to which evaluating compliance with total recoverable aluminum is over-protective by assuming the particulate phase consists of aluminosilicates.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0072 *(Paul Bedore, M.S., Senior Scientist, Robertson-Bryan, Inc. (RBI on behalf of Port of Stockton, San Joaquin County, California)*	*Comment 2: The draft aluminum criteria or compliance testing should account for the fact that aluminosilicates are largely not bioavailable relative to aluminum-containing chemical species that currently form the basis of the draft aluminum criteria.* *Aluminum in aluminosilicates is not directly bioavailable, meaning the most abundant aluminum-containing particulate species occurring in natural aquatic environments is not the toxicologically relevant form of aluminum. There are numerous species of aluminosilicates that can be present in the environment. USEPA's ECOTOX database contains acute toxicity test results for two aluminosilicates (bentonite and kaolinite) and two aquatic organisms (Rainbow Trout (Oncorhynchus mykiss) and Daphnia pulex), which help illustrate this point (USEPA, 2017b). Survival LC50s for these species were available for the two aluminosilicates on a dry weight basis (i.e., µg aluminosilicate per liter), and the aluminum content of the respective aluminosilicates was used to convert the LC50s to an "as aluminum" basis (i.e., µg aluminum per liter). As shown in Table 1, the LC50s (in µg aluminum per liter) for the two aluminosilicates are > 200,000 µg/L.* *Aluminum toxicity data utilized by USEPA to update the draft aluminum criteria were based on toxicity studies with aluminum salts that are readily dissolvable in water, and such aluminum species are of significantly greater bioavailability than aluminosilicates. USEPA accompanied the Draft Report with the MS Excel file "Aluminum Criteria Calculator v1.0 Macro" (USEPA, 2017c), from which the Genus Mean Acute Value (GMAV) for Oncorhynchus spp. and Daphnia spp. could be calculated for the aluminum toxicity dataset used to develop the draft aluminum criteria (i.e., studies using aluminum salts). The GMAVs for Oncorhynchus spp. and Daphnia spp. for aluminum salts are compared to the LC50s for Rainbow Trout and D. pulex with bentonite and kaolinite, respectively, in Table 1. The Rainbow Trout LC50 for bentonite (200,000 µg/L) is 41 times higher than the GMAV for Oncorhynchus spp. with aluminum salts (4,860 µg/L). Further, the D. pulex LC50 for kaolinite (>235,000 µg/L) is >66 times higher than the GMAV for Daphnia spp. with aluminum salts (3,519 µg/L). Toxicity testing data for the aluminosilicates bentonite and kaolinite illustrate the fact that aluminosilicates represent a form of aluminum in water of significantly different*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	chemical form, reactivity, and bioavailability relative to the aluminum species that form the basis of the draft aluminum criteria – aluminum salts and the sparingly soluble aluminum hydroxide particulates or colloids with which dissolved aluminum species are in equilibrium. *Since aluminosilicates are one of the most environmentally prevalent aluminum species in natural waterways, their bioavailability is significantly lower than bioavailability of aluminum species used to revise the draft aluminum criteria, and they are measured in the total recoverable aluminum analysis, it is appropriate to account for their presence and bioavailability when setting federal water quality criteria. Various means to account for the non-bioavailable fraction should be considered, and the most appropriate approach should be incorporated into the Draft Report and/or draft aluminum criteria. Means to account for the bioavailability of aluminum in a water sample could include, but are not limited, to the following.* • *Since by far, the most prevalent forms of particulate aluminum in the environment are aluminosilicates (Filella, 2007), and not sparingly soluble aluminum particulates that may be present in lab-based experiments using aluminum salts, the Draft Report could allow compliance monitoring using the dissolved aluminum fraction of a water sample.* • *Extensive research has gone into developing methodologies for estimating bioavailable aluminum in natural water samples (see Berger et al. 2008 and citations therein), and the literature, as well as experts in aluminum minerology and chemistry, could be consulted in the development of a methodology for estimating the bioavailable aluminum fraction of a water sample for the purposes of assessing compliance with the draft aluminum criteria.*		
EPA-HQ-OW-2017-0260-0073 *(Curt Wells, Director of Regulatory Affairs, The Aluminum Association)*	***Test methods for aluminum in water*** *The extrapolation of laboratory toxicity data for aluminum to regulatory criteria implementation in natural waters has long been problematic due to the complex chemistry of precipitated and solid-phases of aluminum. EPA notes in the draft criteria that natural waters contain mineral particulate forms of aluminum that are subject to measurement uncertainty when using 'total recoverable' measurements of aluminum. This is a critical issue.*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	The EPA must provide comprehensive guidance that allows states and agencies to manage this uncertainty in both interpreting the toxicity data and applying aluminum criteria in a meaningful and not overly prescriptive way. Below are the Association's requested considerations for the development of additional EPA guidance in this area. *Most laboratory toxicity tests use a 'total' aluminum method to express the concentration of aluminum present in the test solutions. This method uses an acidification step to dissolve any precipitated forms of aluminum that might be present, however, in laboratory waters there are no suspended solids which likely will not dissolve with just this simple acidification. With respect to measurement of aluminum in natural waters, total recoverable methods overestimate the potential risks of toxicity due to their additional and more aggressive digestion step which dissolves non-bioavailable mineral phases of aluminum contained in the suspended solids. The Association is concerned that absent further EPA explanation and guidance in this area that false positive outcomes in the implementation of the criteria will often be generated in that total recoverable aluminum concentrations will exceed the criteria, whereas the true bioavailable concentration of aluminum would not exceed the criteria.* *The Association believes that the best means of avoiding the above-noted issues in implementing the new aluminum water quality criteria is to pair it with a test method that most accurately reflects the actual amount of bioavailable aluminum present in a waterbody. The Association is supporting development of a modification to the acid soluble test described in the existing EPA 1988 national aluminum criteria. This modification uses a pH 4 extraction method to obtain bioavailable aluminum fractions and a summary of the proposed method is provided as an attachment. This method would capture potentially bioavailable hydroxide and/or colloidal fractions that are underestimated by alternative coarse pre-filtration strategies currently being specified or considered by state water quality agencies (e.g., New Mexico). Although the Association will be working with EPA in the near future on the validation of this modified methodology, we recognize that it is not yet available for Clean Water Act compliance purposes. However, a more thorough explanation by EPA of the uncertainties, and potential for unnecessary stringency,*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	regarding the use of total recoverable aluminum concentrations in natural waters and how a modification to the test method might address these issues, is needed to inform the proper ultimate implementation of the revised criteria.		
EPA-HQ-OW-2017-0260-0075 *(Steven A. Buffone, CHHM, QEP, GIT, Supervisor, Compliance and Regulatory Affairs, CONSOL Energy Inc.)*	*For permitting purposes, the existing aluminum criteria are implemented as effluent limitations for total recoverable Aluminum. Because much of the aluminum in natural waters is in the form of weathered soils and rocks, many NPDES permittees have struggled to comply with water quality-based effluent limits (WQBELs) for aluminum, especially for precipitation-induced discharges. In these cases, noncompliance is associated with the presence of very low concentrations of naturally occurring sediment or suspended solids. In the total recoverable form, Aluminum is not bioavailable and is consequently, not toxic to aquatic life.* *This issue is recognized in one of the primary studies cited in EPA's Draft Aluminum Criteria. Total recoverable aluminum includes both the suspended sediment form of aluminum and the dissolved form of aluminum, resulting in a misrepresentation of water toxicity. Total recoverable aluminum overestimates exposure concentrations to aquatic organisms in natural waters owing to the strong acid digestion steps prescribed by EPA approved analytical test methods.* • *We request that US EPA review the use of dissolved aluminum in the proposed criteria, in place of total aluminum.* • *We also stress that is important that individual states retain their ability to utilize translator studies to evaluate the impact of dissolved aluminum to instream water. EPA should include a statement within the recommended criteria affirming that translator studies are allowed and that the associated limits be adjusted accordingly.*		
EPA-HQ-OW-2017-0260-0067 *(Patrick McDonnell, Secretary, Pennsylvania Department of Environmental Protection (DEP))*	*On October 1, 1993, EPA released a detailed memo entitled "Additional Material for the Water Quality Handbook." In the memo, EPA recommended that "State water quality standards be based on dissolved metal." While the agency recognized that particulate material could be toxic, it reasoned that this bioavailability/toxicity should be less than that of dissolved toxins, noting that "the primary mechanism for water quality toxicity is adsorption at the gill surface which requires metals to be in dissolved form." EPA further stated that "The ambient water*		

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	quality criteria are neither designed nor intended to protect sediments..." The 2017 draft criteria on aluminum appears to contradict this earlier guidance by calling for a "total" instead of a "dissolved" water quality standard for aluminum. *Are the 1993 guidelines now considered overruled in general, or overruled only in the case of aluminum? If the latter is the case, can you clarify why aluminum is an exception?*		
EPA-HQ-OW-2017-0260-0064 *(Scott G. Mandirola, Director, West Virginia Department of Environmental Protection (WVDEP))*	*Regarding the Draft Aluminum Criteria, while WVDEP generally concurs with EPA that hardness-based aquatic life criteria for aluminum is appropriate, West Virginia disagrees with the criteria being expressed as a total recoverable standard, as it includes aluminum which would never typically be dissolved in the aquatic environment. While it has been well-established that aluminum bioavailability and thus its toxicity revolves largely upon the extent to which aluminum is dissolved into the water column (Gensemer and Playle 1999) [Gensemer, R. W., and R. C. Playle. 1999. The bioavailability and toxicity of aluminum in aquatic environments. CRC Critical Reviews in Environmental Science and Technology 29:315-450.], the methods used to force inorganic aluminum to become dissolved in a laboratory environment do not accurately mimic any natural processes which occur in the actual environment. This assertion has, in fact, been recently confirmed in analysis of field samples using various digestion methods, comparing the total recoverable aluminum results of these methods to dissolved aluminum concentration, at various levels of total suspended solids. The results of one such study published last year, conducted by Thomas He and Paul Ziemkiewicz and published in the journal Chemosphere, indicated that "dissolved aluminum did not respond to increasing total suspended solids concentrations while determined total recoverable aluminum increased with total suspended solids, indicating varying degrees of clay dissolution and, thus bias in the total recoverable aluminum concentration" (He and Ziemkiewicz 2016) [He, Y. Thomas, Ziemkiewicz, Paul F. 2016. Bias in determining aluminum concentrations: Comparison of digestion methods and implications on Al management. Chemosphere 159: 570-576.] Regarding the EPA method used to determine total recoverable aluminum, this study further concludes:* *"USEPA method 200.7 is far more aggressive than even the most severely polluted streams in Appalachia and releases significant Al*	Current research indicates that pH, DOC and hardness all affect aluminum bioavailability and toxicity, and EPA's 2018 aluminum criteria reflects this science and recommends all three parameters be included in criteria to most accurately reflect potential effects of aluminum in ambient waters. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. If aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. The current EPA approved CWA Test Method (Methods 200.7 and 200.8) for aluminum in water and wastes by inductively coupled plasma-atomic emission spectrometry and inductively-coupled plasma-mass spectrometry measures total recoverable aluminum (U.S. EPA 1994a,b). This method is based on acid soluble aluminum where the sample is acidified to pH<2 and then filtered through a 0.45 µm filter. This process does dissolve the monomeric and polymeric forms of aluminum, in addition to colloidal, particulate, and clay aluminum. However, the EPA Methods 200.7 and 200.8 are the currently approved methods for aluminum. In the 2018 Final aluminum criteria document, the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as	

Comment Number (Organization)	Public Comment on Topic 19: Regarding implementation issues with measuring aluminum	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	from the clay structure. Our results indicate that, as a result, it significantly over-estimates total recoverable aluminum and, thus, overestimates the amount of Al that might be released under realistic, field conditions." (He and Ziemkiewicz 2016). *Because West Virginia soil is dominated by fine clays, the use of strong acids to dissolve inorganic aluminum into the water column to then measure it as "total recoverable" greatly overestimates the toxicity of aluminum in the aquatic environment. Therefore, West Virginia requests that EPA re-examine the inclusion of "total recoverable aluminum" as opposed to the dissolved or bioavailable portion of aluminum.*	Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters.	

TOPIC 20: Comments regarding EPA policies

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0064 *(Scott G. Mandirola, Director, West Virginia Department of Environmental Protection (WVDEP))*	*West Virginia is also concerned that EPA is adopting yet another aquatic life criterion while its 1985 Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and Their Uses is outdated and not based on the latest data evaluation methods (USEPA Guidelines 1985) [USEPA. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. United States Environmental Protection Agency, Washington, D.C. NTIS No. PB85-227049. 98 pages. http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/upload/85guidelines.pdf] As EPA states on its website, the 1985 Guidelines are in need of revision. In fact, EPA states:* *"the existing Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and Their Uses have not been updated since 1985. Although based on science of that time, the past 30 years have witnessed substantial scientific advancement in aquatic toxicology, aquatic biology, fate, transport, and effects modeling, and ecological risk assessment. Such advancements, coupled with increasing complexity of water quality impairment issues requires criteria derivation approaches beyond the existing Guidelines methods" [https://www.epa.gov/wqc/aguatic-life-criteria-and-methods-toxics#guide]* *Indeed, if the 1985 Guidelines are still considered valid, then EPA should have used them to develop this Draft Aluminum Criteria; if they are not, new guidelines should be developed before any new criteria are recommended. In fact, EPA developed the current Draft Aluminum Criteria outside the boundaries established in the 1985 Guidelines, including the use of a multiple linear regression model, the use of which was never addressed in the 1985 Guidelines.*	The 1985 Guidelines remain valid, and were followed in the development of the aluminum criteria. The 1985 Guidelines document contains a “best available science” clause that allows the EPA to pursue different avenues for criteria derivation, if they are scientifically defensible. EPA plans to update the 1985 Guidelines including robust public engagement and peer review. The 1985 Guidelines did specifically discuss the concept of toxicity data normalization and criteria development based on water chemistry. In Section VII.B on page 22 of the 1985 Guidelines states: “When enough data are available to show that chronic toxicity to at least one species is related to a water quality characteristic, the relationship should be taken into account…If two more factors affect toxicity, multiple regression analysis should be used.” Additionally, 1985 Guidelines Section VII.C states “Because the best documented relationship is that between hardness and acute toxicity of metals in fresh water and a log-log relationship fits these data, geometric means and natural logarithms of both toxicity and water quality are used. For relationships based on other water quality characteristics, such as pH, temperature, or salinity, no transformation or a different transformation might fit the data better…” The MLR approach to normalizing aluminum toxicity data was published twice in peer-reviewed journals by internationally-recognized experts in the field of metal bioavailability and toxicity (DeForest et al 2018 a,b). The final 2018 aluminum criteria document has also separately undergone independent, external expert peer review and represents the best available science. The MLR models underlying the criteria were all also subjected to independent external peer reviewed, with positive feedback. The 2018 final aluminum criteria represent the best available science using the most current bioavailability and toxicity information on aluminum. The final aluminum criteria take into consideration the impact of water chemistry, including	No edits.

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		all key factors (pH, DOC and hardness) on toxicity.	
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	***The 1985 Guidelines*** *More than thirty years has passed since US EPA prepared the 1985 Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses (the 1985 Guidelines). In this time, US EPA has made no progress in developing criteria that are representative of the actual chemistry in surface waters. Scientists are far too busy conducting worst-case scenario studies in laboratories rather than evaluating what is truly occurring in surface waters. Regulators appear immune to the social, economic, and environmental cost of the over-regulation of naturally occurring substances and the subsequent overtreatment of surface waters to comply with imaginary numbers developed in the laboratory.* *When West Virginia adopted its hardness-based criteria, US EPA reviewed the proposed revision for compliance with the 1985 Guidelines. US EPA does not hold itself to these same standards. The Draft Aluminum Criteria make use of a newly published multiple linear regression (MRL) model. The approach used to develop the MLR is not addressed in the 1985 Guidelines. Inadequate time has been provided to review the validity of this complex approach. Whereas the MLR may be sufficient for publication in a scientific journal, it has not been established as a regulatory tool. If US EPA seeks deference to this approach from States, then the 1985 Guidelines should be revised to provide the basic parameters for preparation of a satisfactory MLR so that stakeholders can evaluate its validity for criteria development. States and regulated entities are being forced to accept criteria developed by mechanisms for which no technical boundaries have been established. Specific comments on the MLR are addressed in a separate section herein.* *Likewise, US EPA disregards the requirement for eight difference taxonomic groups for development of the chronic criterion. The 1985 Guidelines set forth minimum data requirements for development of aquatic life criteria. The acute dataset is typically more robust than the available chronic data, and therefore the criteria are often prepared by utilizing an acute to chronic ratio for calculation of the chronic criterion. Only seven taxonomic groups are represented in the chronic database for the Draft*	The 1985 Guidelines remain valid and were followed in the development of the aluminum criteria. Further, the final aluminum criteria take into consideration the impact of water chemistry on toxicity. The 1985 Guidelines did specifically discuss the concept of toxicity data normalization and criteria development based on water chemistry. In Section VII.B on page 22 of the 1985 Guidelines states: "When enough data are available to show that chronic toxicity to at least one species is related to a water quality characteristic, the relationship should be taken into account…If two more factors affect toxicity, multiple regression analysis should be used." Additionally, 1985 Guidelines Section VII.C states "Because the best documented relationship is that between hardness and acute toxicity of metals in fresh water and a log-log relationship fits these data, geometric means and natural logarithms of both toxicity and water quality are used. For relationships based on other water quality characteristics, such as pH, temperature, or salinity, no transformation or a different transformation might fit the data better…" The MLR approach to normalizing aluminum toxicity data was published twice in peer-reviewed journals by internationally-recognized experts in the field of metal bioavailability and toxicity (DeForest et al 2018 a,b). The final 2018 aluminum criteria document has also separately undergone independent, external expert peer review and represents the best available science. The EPA disagrees that there has been no progress in developing criteria that are representative of the actual chemistry in surface waters. The final 2018 criteria are able to address a substantial percentage of the waters found in the U.S. Very low pH waters (less than pH 5) and high pH waters (pH greater than 10.5) are examples of waters that are not directly represented because the EPA determined not to extrapolate to those pHs. The EPA disagrees with the comment about the limited size	No edits.

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	Aluminum Criteria. Instead of utilizing the robust acute database and the acute to chronic ratio, EPA proceeded with the development of the chronic criterion directly from the incomplete chronic database. *US EPA dismisses the limited size of the chronic database as meaningless, using a tree frog study that does not qualify for inclusion to round out the required eight taxonomic groups. The chronic database relies on only twelve genus mean chronic values (GMCVs), compared to eighteen GMAVs in the acute database. The robustness of the database affects the calculated final chronic value (FCV). The following are the criteria from the US EPA database, assuming only an increase to N (the total number of GMCVs):* *[Table 2]* *Therefore, EPA's use of a limited chronic database directly affects the Draft Aluminum Criteria.* *If US EPA believes the 1985 Guidelines are arcane, then they require revision. This should be done prior to development of new criteria, not afterward (or worse, never). We are years past the development of the copper biotic ligand model, and the 1985 Guidelines have not been revised to address this novel approach. US EPA cannot continue to change criteria development without amending the applicable guidelines.*	of the chronic database and the EPA determined that the data fulfilled the guideline requirements. The CCC was calculated using the eight family MDR approach as recommended by the Guidelines. There is less uncertainty associated with this approach than there is using acute to chronic rations to estimate chronic data.	

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0012 *(Nancy Sonafrank, Program Manager, Alaska Department of Environmental Conservation (ADEC))*	*The Alaska Department of Environmental Conservation (ADEC) has reviewed the U.S. Environmental Protection Agency's (EPA) Draft Aquatic Life Ambient Water Quality Criteria (AWQC) for Aluminum in Freshwater provided to the states for comment by September 26, 2017. ADEC appreciates the opportunity to comment on these draft recommendations.* *Under Clean Water Act (CWA) section 303(c), EPA requires states to regularly review and update CWA 304(a) criteria based on EPA recommendations. While this is a good goal and has the potential to help maintain strong state and national water quality standards programs, it is premature to require states to adopt further revisions to criteria until EPA acts on the tremendous backlog of revised water quality standards already adopted by states and provides updated implementation tools (e.g., variances for new criteria may require a tool for determining substantial and widespread economic and social impacts that may result from implementation of the new criteria).* *ADEC recognizes EPA's efforts to compile and review the data quantifying the toxicity of aluminum to aquatic organisms while assessing the basis for a criterion that will protect population assemblages of fish, amphibians, aquatic invertebrates and plants.*	States are required to review their WQS on a triennial basis. For parameters for which the EPA has issued new or revised 304(a) criteria recommendations, the WQS regulation at 131.20(a) requires that "if a State does not adopt new or revised criteria for parameters for which the EPA has published new or updated CWA section 304(a) criteria recommendations, then the State shall provide an explanation when it submits the results of its triennial review to the Regional Administrator consistent with CWA section 303(c)(1) and the requirements of paragraph (c) of this section." The regulation does not, however, require states to adopt revised criteria based on the EPA's latest recommendation.	No edits.
EPA-HQ-OW-2017-0260-0050 *(J. Tyler White, President, Kentucky Coal Association (KCA))*	***Perform More Rigorous Peer Review*** *KCA is concerned that EPA has adopted an overly literal definition of "peer review" by having its Draft Criteria reviewed only by employees of the agency. Any Draft Criteria should be subject to more rigorous peer review that includes the views of scientists who work outside the agency, and particularly those with an understanding of the real world implications and implementation difficulties raised by the Draft Criteria.*	The commenter is incorrect. In additional to internal EPA expert peer review, the aluminum aquatic life was reviewed by independent external experts in the field of aquatic toxicology, as is the case for all EPA aquatic life water quality criteria. First, the 2017 Draft criteria document was reviewed by five independent external peer reviewers, and their comments and the EPA's associated responses are publicly available. The 2017 underlying bioavailability modeling approach was also independently, externally peer reviewed. These external expert peer reviews of the 2017 draft criteria document can be found at: https://www.epa.gov/wqc/2017-draft-aquatic-life-criteria-aluminum-freshwater. Following the 2017 public comment period and criteria revisions, the 2018 criteria basis underwent 3 additional external expert peer reviews. The two new toxicity studies included in the 2018 MLR models were externally peer	No edits.
EPA-HQ-OW-2017-0260-0065 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	***US EPA's Peer Reviewers*** *US EPA's peer review of the Draft Aluminum Criteria follows the most literal interpretation possible of that term:* ***All seventeen individuals listed as reviewers of the Draft Aluminum Criteria are direct employees of US EPA****. Peer review also requires a certain level of expertise in the topic, which in this case is the bioavailability and toxicity of aluminum to aquatic life.* *The peer reviewers are generally high-level officials within US EPA. Direct experience in water quality criteria development does not appear to be a prerequisite for peer review, nor does expertise*		

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	in aluminum toxicity. To provide any real substantive impact on the Draft Aluminum Criteria, a peer reviewer would be required to study the underlying toxicity tests and whether they qualify for inclusion in the Draft Aluminum Criteria. The peer reviewer would then be required to verify the conversion of the data from those toxicity studies to normalized hardness, pH, and dissolved organic carbon (DOC) concentrations. The details of the linear regression model would require verification. This level of review would to ensure that US EPA has not made a fundamental technical error in its approach. The work is both time-consuming and of critical importance. *The peer reviewers were allowed roughly three weeks to answer very specific questions regarding the content and approach presented in the Draft Aluminum Criteria. Instead of providing a detailed critique,* ***the peer review comments (at least as presented in the US EPA summary) are largely gratuitous, intra-agency back-pats or meaningless general discussions without any review or comment on US EPA's fundamental data decisions.*** *Most importantly, perhaps, the peer reviewers should have asked whether the criteria make logical sense: Evaluating whether the calculated criteria present numbers that are reasonable, given what we know about water chemistry and overall concentrations of aluminum in waters within the United States. Based on the peer review summary (once again, compiled by US EPA), the appearance is this largely did not occur. Notably, "Reviewer 4" offered some excellent comments regarding the difference in solubility and behavior among minerals and the kinetics of land scale processes. A few comments mention aluminum speciation and behavior and appear to question the counterintuitive results of the linear regression model across certain pH and hardness concentrations. These comments were obviously not adequately considered, as reflected by the very publication of this draft federal criterion.* *As set forth in the following sections, US EPA appears disinterested in developing aluminum criteria that can be reasonably implemented by the States who will be forced to adopt them once finalized. An obligatory, superficial review by US EPA employees with no vested interest in the impacts of the Draft Aluminum Criteria is a* ***DIRECT INSULT*** *to the many States who*	review by external scientists who are experts in the fields of aquatic toxicity and metal bioavailability. The 2018 MLR models were also externally peer reviewed by experts in the field of aquatic toxicity. These three additional external expert peer reviews can be found at: https://www.epa.gov/wqc/aquatic-life-criteria-aluminum#2018. The names and affiliations of the external peer reviewers are available in the external peer review reports posted on the EPA webpage. These include peer reviewers of the 2017 draft aluminum criteria, peer reviewers of the two additional toxicity studies and peer reviewers of the 2018 MLR models. Prior to, to external expert peer review, EPA conducted internal peer review of the criteria document. The names of the internal peer reviewers included in the criteria document.	

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	have struggled with adoption and implementation of the Ambient Aquatic Life Water Quality Criteria for Aluminum published by US EPA in 1988 (the "1988 Criteria"). Many of these states, like West Virginia, have labored for decades to develop environmentally protective standards that reflect specific conditions only to have them linger at US EPA awaiting federal approval (West Virginia's current proposal has been pending review since October 2015). For West Virginia and other states to now be confronted with a clearly hurried federal proposal is nothing short of offensive.		
EPA-HQ-OW-2017-0260-0050 *(J. Tyler White, President, Kentucky Coal Association (KCA))*	*Pursuant to the Notice of Availability published by the U.S. Environmental Protection Agency ("EPA") in the Federal Register on July 28, 2017 at 82 FR 35,198, the Kentucky Coal Association ("KCA") submits the following comments on EPA's Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater (the "Draft Criteria").* *KCA represents over 80% of Kentucky's coal production, and its membership includes over 120 additional companies that support the coal mining industry. As of 2016, Kentucky was the fourth-largest coal producing state in America.* *KCA's coal-producing members operate in two geographically distinct coal basins: the Central Appalachian basin in the eastern part of the state, and the Illinois Basin in the western part of Kentucky. As such, KCA and its members are acutely aware of the drawbacks of "one size fits all" approaches to environmental regulation that fail to take into account regional differences in geological, chemical, and hydrological conditions. The Draft Criteria represent such a misguided attempt at national regulation in an area where a state-by-state approach is more appropriate. Accordingly, KCA requests that EPA withdraw the Draft Criteria and leave decisions related to aluminum in freshwater to state permitting authorities, who have more expertise with respect to local conditions and the real-world impacts (or lack thereof) of aluminum in surface waters.*	The aluminum criteria are recommendations for the states and authorized tribes and are not water quality standards. The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). States may also adopt other scientifically defensible criteria that are scientifically defensible and protect the designated use. EPA has not identified aluminum as a priority pollutant, and therefore states are not required to develop state water quality standards for aluminum. The 2018 final aluminum criteria specifically allow for states to adjust the criteria to their local water chemistry conditions, and are thus inherently not a "one size fits all approach."	No edits.
EPA-HQ-OW-2017-0260-0050 *(J. Tyler White, President, Kentucky Coal Association (KCA))*	*The Clean Water Act expressly provides that states should have the primary role of establishing water quality standards and adopting water quality criteria that apply within their borders. Aluminum in particular is a parameter where the primary role of states should be respected. In any document adopting a final recommended criteria for aluminum, EPA must emphasize that the criteria are merely* ***recommended****, and make clear that states are free to, and*		

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	indeed should be encouraged to, adopt state-specific criteria - or no criteria at all - where aluminum criteria are not necessary to protect designated uses. Kentucky provides an important example. As explained by Kentucky's regulators during a prior triennial review, due to the naturally high aluminum concentrations in soils throughout Kentucky, streams that exceed the existing national recommended criteria nonetheless contain healthy and reproducing biological communities. Indeed, "some of the commonwealth's highest quality waterbodies often exceed the criteria." [Kentucky Energy and Environment Cabinet, Division of Water, Statement of Consideration Relating to 401 KAR 10:031 (2012).] There is simply no basis for adoption of stringent criteria - and the staggering compliance costs that accompany them - where streams that exceed the criteria are some of the highest quality in the state and support flourishing aquatic life. *The comments already filed to date by state regulatory authorities demonstrate that a national approach to aluminum regulation is simply inappropriate. States regulators from areas as diverse as Alaska, Kentucky, Texas, Wyoming and others have all raised, in various respects, questions or concerns about the appropriateness of applying a national standard to state-specific waters. In light of the current EPA's repeated statements that it will respect federalism and the important role of its state partners, EPA must make clear in any adopted criteria that states are free to deviate from it to address local conditions.*		
EPA-HQ-OW-2017-0260-0044 *(Shelly Lemon, Chief, Surface Water Quality Bureau, New Mexico Environment Department)*	*The State of New Mexico has already adopted hardness-dependent criteria for aluminum.* ***The State of New Mexico implores the U.S. EPA to engage and, at the very least, consult with States and Tribes in future development of water quality criteria early in the development process****.*	Thank you for your comment. EPA routinely engages with states and tribes on criteria development through the Association of Clean Water Agencies (ACWA).	No edits.
EPA-HQ-OW-2017-0260-0049 *(Stuart E. McKibbin, Chief of Planning Division, Riverside County Flood Control and Water Conservation District)*	*The EPA should describe how the new 304(a) criteria for aluminum should be applied in states where it has promulgated federal water quality standards for other trace metals under the National Toxics Rule or the California Toxics Rule.*	The EPA's criterion provides recommendations for states and authorized tribes to consider in their adoption of water quality standards under CWA section 303(c). Other implementation documents that the EPA is developing related to these aluminum criteria are intended to provide assistance to states and authorized tribes that adopt into the water quality standards a criterion based on or similar to the EPA's recommended criterion. The implementation documents are also intended to provide assistance to other stakeholders and the public. The EPA recognizes that there are several aspects	No edits.

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
		of the recommended criterion that will benefit from technical support documents to enhance implementation of state and tribal criteria and is planning to develop such documents and make them available for public comment.	
EPA-HQ-OW-2017-0260-0050 *(J. Tyler White, President, Kentucky Coal Association (KCA))*	***The Abundance of Aluminum In the Natural Environment*** *Despite recognizing that aluminum is one of the most abundant metals in the Earth's crust, EPA fails to acknowledge the implications of this finding. Simply put, if most of the earth's crust contains aluminum, it is illogical to adopt regulatory policies aimed at the near-total elimination of aluminum from surface waters. As the Kentucky experience demonstrates, many of the highest quality waters in the country contain aluminum concentrations that would exceed the Draft Criteria. The reason that we can have abundant aluminum and healthy streams is that most aluminum is not bioavailable. But despite apparently recognizing that much aluminum in the real world is not bioavailable, EPA has nonetheless relied on aluminum toxicity tests that do not use natural geological materials in order to set the standard. This is a clear case of "science" that is divorced from real world application on the ground and therefore sets a standard that is both overly costly and unnecessary for environmental protection.* *Along the same lines, while EPA recites that it has reviewed thousands of aluminum samples in its research, it appears to have ignored hundreds of thousands of aluminum samples taken by those who must comply with existing aluminum criteria. For example, the thousands of samples reported by West Virginia coal miners each month, and the experience of those miners in addressing aluminum toxicity at their operations, appear not to have been accounted for in any meaningful way in the Draft Criteria. The experience of those coal operators, if taken into account, should cause EPA to stop this effort in its tracks. This is because our members who operate in West Virginia report that the efforts undertaken to treat discharges to reduce aluminum content result in more environmental harm than benefit. Without taking into account the unintended consequences of establishing overly stringent water quality criteria, EPA is ignoring sound science.*	The EPA's aluminum criteria reflect the best available science, based on bioavailable aluminum. Dissolved, colloidal and precipitated forms of aluminum are all bioavailable to aquatic organisms, which supports the criteria as total aluminum. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. In the 2018 Final aluminum criteria document the EPA has noted that external research on new analytical methods is ongoing to address concerns with aluminum bound to particulate matter (i.e., clay) from natural waters being included in the total recoverable aluminum concentrations. This approach would not acidify the sample to pH<2 but rather to a higher pH to better capture the bioavailable fraction of aluminum. The method has been published as Rodriguez, P.H., J.J. Arbildua, G. Villavicencio, P. Urrestarazu, M. Opazo, A.S. Cardwell, W. Stubblefield, E. Nordheim, and W. Adams. 2019. Determination of Bioavailable Aluminum in Natural Waters in the Presence of Suspended Solids. Environ. Toxicol. Chem. 29 April 2019. https://doi.org/10.1002/etc.4448. The expectation is that this approach may better estimate the bioavailable fraction of aluminum in natural waters. To the best of our knowledge, the EPA has reviewed all aluminum toxicity studies available at this time. The public comment period was open to allow for submission of any additional research that the public may identify.	No edits.

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	*States should be allowed to retain existing dissolved criteria. Many states currently express aluminum aquatic life criteria as dissolved criteria and/or allow aluminum translator studies to be conducted on a site-specific basis (U.S. EPA 1996). UWAG recommends that EPA add language specifying that the final criteria, if still expressed as total recoverable concentrations, should not supersede previously state-adopted (and EPA approved) dissolved aquatic life criteria for aluminum.*	The EPA's aluminum criteria are based on total recoverable aluminum toxicity in laboratory studies and the criteria document reflects consideration of what is bioavailable to aquatic organisms in the natural environment as described in the latest high quality peer reviewed literature. Dissolved, colloidal and precipitated forms of aluminum may all be bioavailable to aquatic organisms, which supports the criteria as total aluminum. If aluminum criteria are based on dissolved concentrations, toxicity would likely be underestimated, as colloidal forms and hydroxide precipitates of the metal that can dissolve under natural conditions and become biologically available would not be measured. Current research and methods development for aluminum analytical methods are expected to improve quantification of the bioavailable aluminum. For parameters for which the EPA has issued new or revised 304(a) criteria recommendations, the WQS regulation at 131.20(a) requires that "if a State does not adopt new or revised criteria for parameters for which the EPA has published new or updated CWA section 304(a) criteria recommendations, then the State shall provide an explanation when it submits the results of its triennial review to the Regional Administrator consistent with CWA section 303(c)(1) and the requirements of paragraph (c) of this section." The regulation does not, however, require states to adopted revised criteria based on the EPA's latest recommendation. The EPA's final 304(a) recommendation does not constitute a federal promulgation for states. Until and unless a state adopts a revision to its own aluminum criteria the state's previously adopted and the EPA-approved criteria are applicable for CWA purposes.	No edits.
EPA-HQ-OW-2017-0260-0064 *(Scott G. Mandirola, Director, West Virginia Department of Environmental Protection (WVDEP))*	*The West Virginia Department of Environmental Protection (WVDEP) thanks the Environmental Protection Agency (EPA) for the opportunity to comment on its Draft Aquatic Life Ambient Water Quality Criteria for Aluminum 2017 (Draft Aluminum Criteria). WVDEP offers the following comments on the Draft Aluminum Criteria.* *West Virginia first adopted EPA's 1988 recommended aquatic life*	The EPA's response to specific state packages submitted to the EPA is outside the scope of this response to comments.	No edits.

Comment Number (Organization)	Public Comment on Topic 20: Regarding EPA policies	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	water quality criteria for aluminum in 1993. After adopting the recommended criteria, West Virginia made several changes to it over the years as additional data on aluminum toxicity accumulated. In 1997, West Virginia revised its aluminum criteria by removing the chronic portion of the standard, which at that time had been 87 µg/l; this revision was subsequently disapproved by EPA. By 2005, the West Virginia Environmental Quality Board who then managed the state's Water Quality Standards, had re-inserted the chronic criterion at 87 µg/1, and specified the criteria as being for dissolved aluminum. In 2008, after WVDEP had taken over management of standards, West Virginia adopted a standard for dissolved aluminum which included 750 µg/l acute and chronic exposure for warm waters, and 750 µg/l acute exposure and 87 µg/l chronic exposure for trout waters. This dissolved aluminum water quality standard was subsequently approved by EPA. Then, in 2015, after studying research which indicated aluminum to be dependent upon hardness, West Virginia revised its dissolved aluminum criteria by amending Legislative Rule 47 CSR 2, Requirements Governing Water Quality Standards [Current version of 47 CSR 2 found here: http://dep.wv.gov/WWE/Programs/wqs/Documents/47CSR2%20070816. pdf], submitting the rule to EPA for review and approval on October 26, 2015. This change, which remains in 47 CSR 2 and awaits EPA approval or disapproval, would implement a hardness-based criterion only for the pH range of 6.5 to 9.0. Above and below this pH, WV's previous aluminum criterion is still in place. EPA commented on West Virginia's aluminum criteria revision in February 2016, citing EPA's ongoing effort to revise the existing criteria recommendations for aluminum, [http://dep.wv.gov/WWE/Programs/wqs/Documents/EPA%20Documents/EPA%20Comments%20on%20WV%20Se%20and%20Al%202-23-16.pdf]" and again in March 2016 to share limited preliminary results from the mussel study they had requested West Virginia wait for completion of in 2013. However, West Virginia has received no official response regarding approval or disapproval of the aluminum criteria revision WVDEP submitted to EPA 24 months ago, although this determination is required of EPA pursuant to Section 303(c) of the Clean Water Act.		

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EPA-HQ-OW-2017-0260-0075 *(Steven A. Buffone, CHHM, QEP, GIT, Supervisor, Compliance and Regulatory Affairs, CONSOL Energy Inc.)*	*We also feel that it's important that the states retain their primacy and be allowed to develop their own criteria or adopt the recommended criteria or portions of it as they feel is appropriate for their unique regional variations.*	The aluminum AWQC are recommendations for the states and authorized tribes and are not water quality standards. States may adopt the 304(a) criteria into their water quality standards and can also adopt other criteria if they are scientifically defensible and protective of use, as determined by the state.	No edits.

TOPIC 21: Comments regarding the regulatory burden of aluminum criteria

Comment Number (Organization)	Public Comment on Topic 21: Regarding the regulatory burden of aluminum criteria	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0030 (Nelson Brooke, Riverkeeper et al., Black Warrior Riverkeeper)	*Thank you for the opportunity to provide comments on the above-referenced recommendation regarding the application of ambient water quality criteria for aluminum. We write on behalf of Black Warrior Riverkeeper ("Riverkeeper"), a nonprofit organization dedicated to protecting and restoring the Black Warrior River and its tributaries. Currently, several streams in the Black Warrior River watershed are impaired due to excessive concentrations of aluminum, with TMDLs having already been approved. Several other streams and river segments are also at risk for aluminum impairment due to excessive contributions from existing and/or abandoned facilities. We are concerned with the proposed recommendation because of the potential implications it could have for state regulators, as well as organizations such as Riverkeeper, which have a vested interest in protecting water quality, and must rely on EPA guidance in enforcing specific water quality criteria.* *Riverkeeper enthusiastically supports the idea of basing regulatory decision-making on the application of the best scientific literature available and expanded data sets. We believe that the proposed guidance is a well-intended effort to do just that. However we fear that in its haste to update the science supporting the proposed recommendation to include the multiple linear regression (MLR) model, EPA has actually done little more than unnecessarily complicate the calculation of aluminum criteria in a manner that will increase costs to regulators (and non-profit organizations, such as ours), and increase the uncertainty of the site-specific criteria by compounding the standard of error in each calculated measurement (Al, pH, DOC, and Hardness), resulting in criteria calculations that are less protective of water quality in most cases.*	The EPA based its 2018 aluminum criteria on publicly available, peer-reviewed science, with the underlying model and toxicity data largely developed by external leaders in the field.	No edits.
EPA-HQ-OW-2017-0260-0031 (Robert P. Baumgartner, Regulatory Affairs Department Assistant Director, Clean Water Services (District))	*Clean Water Services (District) appreciates the opportunity to comment on the U.S. Environmental Protection Agency's proposed aquatic life water quality criteria for aluminum. The District is a county service district, located in Washington County, Oregon, providing sanitary sewer service, stormwater management and environmental restoration for more than 560,000 residents and the businesses and industries that support the local and global economy. The District holds an integrated watershed-based NPDES permit covering the sanitary sewer conveyance system, four wastewater treatment plants and the municipal separate storm sewer system serving urbanized Washington County. Adoption of*	The EPA based its 2018 aluminum criteria on publicly available, peer-reviewed science, with the underlying model and toxicity data largely developed by external leaders in the field. The aluminum AWQC are recommendations for the states and authorized tribes and are not water quality standards. States may adopt the 304(a) criteria into their water quality standards and can also adopt other criteria if they are scientifically defensible and protective of use, as determined by the state.	No edits.

Comment Number (Organization)	Public Comment on Topic 21: Regarding the regulatory burden of aluminum criteria	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	the draft aluminum criteria in its current form would significantly impact the District and the communities it serves with little to no added benefit to water quality.		
EPA-HQ-OW-2017-0260-0065 (Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))	*WVCA is concerned with the overall approach by US EPA in preparing, peer reviewing, and publishing the Draft Aluminum Criteria. As set forth more fully below, the effect of US EPA's insular view of aluminum chemistry creates a circumstance where the capital and compliance costs of the Draft Aluminum Criteria will be staggering, while providing little or no actual environmental protection or enhancement.*	The EPA based its 2018 aluminum criteria on publicly available, peer-reviewed science, with the underlying model and toxicity data largely developed by external leaders in the field. The aluminum criteria and underlying basis underwent 5 independent, external expert peer reviews; these reports and EPA's responses are available on EPA's website (https://www.epa.gov/wqc/aquatic-life-criteria-aluminum). The aluminum AWQC are recommendations for the states and authorized tribes and are not water quality standards. States may adopt the 304(a) criteria into their water quality standards and can also adopt other criteria if they are scientifically defensible and protective of use, as determined by the state.	No edits.

TOPIC 22: Comments regarding a request for an extension on the comment period

Comment Number (Organization)	Public Comment on Topic 22: Regarding a request for an extension on the comment period	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0050 *(J. Tyler White, President, Kentucky Coal Association (KCA))*	***Inadequate Time for Public Input*** *The public has not been given sufficient time or opportunity to review the use of the MLR, which forms the underpinning of much of the Draft Criteria but was only published recently. More generally, KCA and other impacted members of the public cannot be expected to reasonably comment on the numerous technical considerations that have formed the Draft Criteria in the time provided. Given that states have struggled for years to apply the 1988 criteria, in many cases without resolution, it is unreasonable for EPA to assume that the voluminous information in the new criteria can be fully analyzed and addressed in the short timeframe for public comment.*	A 60-day review period is typical for a water quality criteria document. Since an additional 30 days was added onto the review period (total of 90 days), the EPA believes that a sufficient amount has been allotted for document review by the public.	No edits.
EPA-HQ-OW-2017-0260-0061 *(Penny Shamblin, Hunton & Williams LLP on behalf of Utility Water Act Group (UWAG))*	***<u>EPA must afford the public access to key technical papers that have yet to be published.</u>*** *As an initial matter, EPA must ensure all the information relied on to establish the Draft Criteria is available for public review and comment. It has not done so in this case. The Draft Criteria cites and is based on MLR models developed by D.K. DeForest and others. Their work, however, currently is unpublished. DeForest, D.K., K.V. Brix, L.M. Tear and W.J. Adams. 2017 (Manuscript). Multiple Linear Regression (MLR) models for predicting chronic aluminum toxicity to freshwater aquatic organisms and developing water quality guidelines. Environ. Toxicol. Chem. (submitted); see also Brix, K.V., D.K. DeForest, L. Tear, M. Grosell and W.J. Adams. 2017 (Manuscript). Use of multiple linear regression models for setting water quality criteria for copper: A complimentary approach to the biotic ligand model. Environ. Toxicol. Chem.* *For stakeholders to be able to meaningfully review and comment on the Draft Criteria, it is essential that the underlying information on which it is based be available to all during the review period.[UWAG understands that members of the Society of Environmental Toxicity and Chemistry (SETAC) have access to the DeForest et al. (2017) unpublished paper. Others, however, do not.] The ability to review the DeForest et al. (2017) paper is especially crucial as it contains the empirical aluminum toxicity data used to develop the MLR models, which in turn are used to develop the acute and chronic criteria. EPA should make these papers available and extend the comment period to afford*	All these studies have been published and are available. All studies are identified in the bibliography of the criteria document.	No edits.

Comment Number (Organization)	Public Comment on Topic 22: Regarding a request for an extension on the comment period	EPA Response	Revision Location in 2018 Aluminum Criteria Document
	stakeholders the opportunity to consider that information in commenting on the Draft Criteria.		
EPA-HQ-OW-2017-0260-0066 *(David Smiga, Assistant General Counsel-Environmental, United States Steel Corporation)*	*The MLR model development papers have not yet been published. The papers should be published to allow stakeholders the ability to review these development documents, along with a comment period of sufficient time to appropriately comment on the scientific approach and validity.*	All these studies have been published and are available. All studies are identified in the bibliography of the criteria document. A 60-day review period is typical for a water quality criteria document. Since an additional 30 days was added onto the review period (total of 90 days), the EPA believes that a sufficient amount has been allotted for document review by the public.	No edits.
EPA-HQ-OW-2017-0260-0071 *(Fredric P. Andes, Coordinator, Federal Water Quality Coalition (FWQC))*	*The papers that document the scientific basis for the MLR models have not yet been published. It is important that stakeholders be able to review these papers before EPA moves ahead to issue recommended criteria based on those models. The Agency should make the papers available, and provide extended time for submittal of comments concerning the papers and their impact on the scientific approach embodied in the Draft Criteria.*		
EPA-HQ-OW-2017-0260-0006 *(State of New Mexico Environment Department)*	*This comment is a request for an extension of the public comment period for the draft "Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater".* *Although this document has been anticipated for some time, the implications this document will have on water quality standards across the nation, once approved, warrants a thorough assessment. Due to the magnitude and level of technical detail used to develop this proposed criteria, the State of New Mexico Environment Department is seeking, at a minimum, an additional 30 days to complete this review, for a total comment period of 90 days.* *Your consideration is greatly appreciated.*	Thank you for your comment. The comment period was extended to be for 90 days.	No edits.
EPA-HQ-OW-2017-0260-0007 *(Anonymous public comment)*	*This comment is a request for an extension of the public comment period for the draft "Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater".* *Potable Water Treatment Facilities in Massachusetts may be subject to Aluminum limits in their NPDES permits and therefore, Massachusetts Water Works Association is seeking, at a minimum, an additional 30 days to complete a review of the proposed criteria, for a total comment period of 90 days.*		

Comment Number (Organization)	Public Comment on Topic 22: Regarding a request for an extension on the comment period	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0009 *(Roger Claff, Senior Scientific Advisor, American Petroleum Institute (API))*	*API requests a 60-day extension, through November 27, 2017, of the public comment period for the U.S. Environmental Protection Agency's (EPA's) Notice of Availability, "Request for Scientific Views: Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater" (82 Fed. Reg. 35198, July 28, 20 17). These draft criteria, derived through data normalization by application of a multiple linear regression model, and addressing the influence of numerous receiving water quality parameters including pH, DOC, and hardness, are technically complex. Aluminum chemistry and effects on aquatic life complicate criteria derivation and implementation. Although API and others have begun an assessment of the draft criteria, a 60-day extension of the comment period is warranted to allow the public to provide meaningful, detailed technical reviews of EPA's criteria derivation process, and to identify and detail their concerns with criteria implementation.*		
EPA-HQ-OW-2017-0260-0011 *(Fredric P. Andes, Federal Water Quality Coalition)*	*On behalf of the Federal Water Quality Coalition, we request a 60-day extension of the comment period for the draft updated aluminum water quality criteria. The new criteria, and EPA's draft guidance, present a series of technically complex scientific issues. The guidance document, along with other related materials, total almost 2000 pages. The current comment period does not provide us with adequate opportunity to perform a careful review of these materials and provide meaningful, comprehensive comments and recommendations. Therefore, we believe that an additional 60 days are needed in order to perform those tasks. We ask that the Agency grant this request before the comment period expires, so all stakeholders know that they have more time to complete their comments. If you have any questions or need any additional information, just let me know. Thank you.*		
EPA-HQ-OW-2017-0260-0015 *(Jason D. Bostic, Vice-President, West Virginia Coal Association (WVCA))*	*The West Virginia Coal Association (WVCA) is writing this letter to respectfully request a 60-day extension of the comment period for the U.S. Environmental Protection Agency's (EPA's) Notice of Availability, "Request for Scientific Views: Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater" (82 Fed. Reg. 35198, July 28, 2017).* *WVCA is requesting a 60-day extension of the public comment period to allow the coal industry in West Virginia to fully evaluate the ramifications of the proposed criteria.*		

Comment Number (Organization)	Public Comment on Topic 22: Regarding a request for an extension on the comment period	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0017 *(John Heggeness, Surface Water Quality Standards and Monitoring Bureau of Water Quality Planning, Nevada Division of Environmental Protection)*	*The Nevada Division of Environmental Protection (NDEP) requests a 30-day extension to the current review period for the draft AWQC for exposure of aquatic life to aluminum in freshwater systems ("Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater.") The NDEP Bureau of Water Quality Planning needs additional time to adequately review the technical details of the document and prepare comments. The revised deadline would be October 26, 2017.*		
EPA-HQ-OW-2017-0260-0018 *(Steven A. Buffone, Compliance & Regulatory Affairs, Consol Energy Inc.)*	*CONSOL Energy Inc. (CONSOL) is requesting a 60 day extension to submit comments on the Environmental Protection Agency (EPA) proposed Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater, Docket ID: HQ-OW-2017-0260-0001. CONSOL owns and operated the premier underground longwall coal mining complex in the United States, located in southwestern Pennsylvania, and additional legacy mining properties that generate water discharges that are often managed under National Pollutant Discharge Elimination System (NPDES) permits.* *CONSOL is requesting this 60 day extension in order to fully assess the impacts of the draft criteria on our ability to meet our existing NPDES discharge limits. These 2017 draft criteria are complex when compared to the 1988 AWQC Criteria, with the addition of species, the derivation of data through normalization by application of a multiple linear regression model, and addressing the influence of numerous receiving water quality parameters including pH, DOC, and hardness. A 60 day comment period is not adequate to complete our review and provide substantial comments to the EPA.* *CONSOL appreciates the opportunity to comment on the Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater and your consideration of our request for additional time.*		

Comment Number (Organization)	Public Comment on Topic 22: Regarding a request for an extension on the comment period	EPA Response	Revision Location in 2018 Aluminum Criteria Document
EPA-HQ-OW-2017-0260-0019 *(Laura Cooper, Division of Water and Waste Management Water Quality Standards, West Virginia Department of Environmental Protection)*	*This comment is a request for an extension of the public comment period for the draft "Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater".* *Although this document has been anticipated for some time, the implications this document will have on water quality standards in West Virginia warrants a thorough assessment. Due to the magnitude and level of technical detail used to develop this proposed criteria, the West Virginia Department of Environmental Protection is seeking, at a minimum, an additional 30 days to complete this review, for a total comment period of 90 days.*		
EPA-HQ-OW-2017-0260-0024 *(Nevada Division of Environmental Protection (NDEP))*	*The Nevada Division of Environmental Protection (NDEP) requests a 30-day extension to the current review period for the draft AWQC for exposure of aquatic life to aluminum in freshwater systems ("Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater.")* *The NDEP Bureau of Water Quality Planning needs additional time to adequately review the technical details of the document and prepare comments. The revised deadline would be October 26, 2017.*		
EPA-HQ-OW-2017-0260-0033 *(Lisa D. Daniels, Acting Deputy Secretary, Pennsylvania Department of Environmental Protection (DEP))*	*The Pennsylvania Department of Environmental Protection (DEP) is requesting an extension to the public comment period for the Draft Updated Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater. DEP needs additional time to be able to more thoroughly review and formulate comments on the draft recommendations for updating the 304(a) aquatic life criterion for freshwater aluminum. The draft recommendations are based, in large part, on data and conclusions from, yet unpublished reports and studies that are not readily available to DEP staff for this review. DEP needs time to better understand the basis for using this new data, and the complexities of the bi-modal nature of aluminum chemistry and toxicity described in the Multi-variate Linear Regression Model used in calculating the updated criteria.*		