EPA RESPONSE
TO PUBLIC COMMENTS

on the

DRAFT AQUATIC LIFE
AMBIENT WATER QUALITY CRITERIA
CADMIUM - 2015

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Office of Water
U.S. Environmental Protection Agency
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EPA-HQ-2016-005391_00061113

INTRODUCTION

EPA's Office of Water is charged with protecting ecological integrity and human health from adverse anthropogenic, water-mediated effects, under the purview of the Clean Water Act (CWA) Section 304(a)(l). The Agency has been working to update water quality criteria to protect aquatic life and aquatic-dependent wildlife from the presence of cadmium in freshwater and estuarine/marine environments in order to reflect the latest scientific knowledge.

EPA's Ambient Water Quality Criteria (AWQC) document for cadmium presents draft acute and chronic criteria expressed as concentrations of cadmium in fresh and estuarine/marine waters (dissolved). The 2016 cadmium criteria document is an update to the 2001 cadmium criteria. The 2016 update incorporates additional toxicological data for cadmium, while using the same criteria derivation process that was used in 2001.

EPA submitted its Draft AWQC for Cadmium – 2015 for public comment on December 1, 2015. The request for scientific views on the draft was open for 90 days, and as of February 1, 2016 ten comments were received (note: one entry was repeated). 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 those public comments provided.

The following tables divide the comments into common topics for ease of the reader (e.g., criteria duration, *Hyalella azteca* data, etc.). Comments are summarized and EPA's responses to the public comments are provided. EPA revised the 2015 draft considering these comments, and noted in the table where the document was edited, when applicable

EPA-HQ-2016-005391_00061114

TOPIC 1: Comments regarding acute criteria duration change from 24 hours to one hour

Comment Number (Organization)	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0012 (Utility Water Act Group)	*UWAG has concerns with EPA's proposal to change the acute freshwater and estuarine/marine criteria averaging duration from 24 hours to 1 hour. The change is not adequately justified and is not supported by new studies in the Draft. The current 24-hour duration should be retained unless a strong scientific justification is presented.* *Every previous iteration of the cadmium criteria has endorsed a 24-hour duration for the acute criteria. EPA appears to be making a policy decision that the acute criteria should be 1 hour, but does not present the associated science to support the revision which is inconsistent with CWA § 304(a)(1), which mandates EPA establish "criteria for water quality accurately reflecting the latest scientific knowledge."* *EPA compares the acute toxicity to ammonia but fails to provide information that compares the time-dependent toxicity of cadmium with ammonia. Furthermore, assessing the toxicity of cadmium during the first 24 hours of an acute test is problematic because the vast majority of published studies reporting the acute toxicity of cadmium do not report patterns of lethality during the first 24 hours. Several acceptable selected studies (Besser et al. 2007; Buhl 1997; Diamond et al. 1997; Mebane et al. 2012; Nebeker 1986) do not report 24-hour LC50s and the one study with relevant data (Duncan and Klavercamp 1983) had a 12-hour LC50 that was five times greater than the 96-hour LC50 (5.35 vs. 1.11 µg/L, respectively). This value would be expected to be similar if cadmium was a fast-acting pollutant.* *An earlier EPA publication (*Speed of Action of Metals Acute Toxicity to Aquatic Life*; EPA-822-R-95-002) also justifies the 24-hour averaging period.*	The statement that "every previous iteration of the cadmium criteria has endorsed a 24-hour duration for the acute criteria" is inaccurate. Only the 2001 final cadmium criteria document used an averaging period of 24 hours, all prior cadmium criteria revisions (1996, 1985, and 1980) and the draft version of the 2001 revision used a one-hour averaging period. Further, with the exception of the criteria derived for freshwater copper, all other acute criteria for aquatic life use an averaging period of one hour. The 1985 Guidelines provides the basis for the 1-hour duration. The criteria document states that "The procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that, except possibly where a locally important species is very sensitive, (1) aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of (2) does not exceed (3) µg/L more than once every three years on the average and if the one-hour average concentration does not exceed (4) µg/L more than once every three years on the average." The 1985 Guidelines additionally state that "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." Accordingly, the one hour averaging period is designed to be conservative and protective based on the potential for latent effects. A detailed discussion of the rationale for selecting the one hour averaging period was presented in Section 5.1.4 of the 2015 draft criteria revision, and is included in the final 2016 criteria document. As noted in this section, the 24-hour duration used in the 2001 final cadmium criteria document was based on a limited number of fish toxicity studies and did not address trends in duration for a broader range of fish species or for other species groups, including aquatic invertebrates.	No edits

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	*This document estimated a kinetic coefficient (*k*) using a regression of LC50 values versus time, with the averaging period being calculated as the inverse of* k*. The larger the* k *value the faster acting the pollutant. None of the estimated averaging periods in the document for freshwater and saltwater species approached 1-hour. The highest estimated* k *values mentioned, for the freshwater fathead minnow, were 6 and 17 hours, with saltwater species having even larger values. The selection of the 1-hour averaging period is baseless and arbitrary.* *Additionally, the 1985 Guidelines say the duration should be "substantially less than 48 to 96 hours," but do not say that 24 hours is an inappropriate duration and therefore the Guidelines do not support, nor should it be a justification for the proposed revision.*	The EPA 1995 document (Speed of Action of Metals Acute Toxicity to Aquatic Life, *EPA-822-R-95-002*) that the commenter refers to is a compilation of a series of memos and data from a contractor to EPA. This 1995 document suggests the possibility of longer averaging periods. However, that 1995 document included tests for only a very few aquatic species, and very little data at observation periods of less than 24 hours was included. Additionally, in Summary Table 1 of this 1995 document, eight of the 11 tests for cadmium indicate an averaging period of *less* than 24 hours; thus an averaging period of 24 hours would not be protective. Additionally, all of the species in the tests in the 1995 document were relatively insensitive to cadmium, less acutely sensitive than 40 other genera, and falling above the 50th percentile in the sensitivity distribution presented in the 2016 criteria document. Thus we do not currently consider this 1995 publication a strong premise upon which to revise the long-standing and standard one-hour averaging period recommended in the 1985 Guidelines, and followed in 44 of the 46 numeric Aquatic Life Criteria that have been published by EPA. Thus, based on the limited nature of the available data, the absence of additional supporting information for other species, and the potential for latent effects, EPA revised the acute duration in the 2015 draft documents to the one-hour duration to be consistent with 1985 Guidelines recommendations and the more protective one hour averaging period used for almost all other criteria. The one-hour duration for the acute criteria is retained in the 2016 final cadmium Aquatic Life Criteria.	
EPA-HQ-OW-2015-0753-0012 (Utility Water Act Group)	*Water Quality-Based Effluent Limits (WQBELs) for cadmium are often expressed as a daily (24-hr) maximum value. Changing the WQBEL to a 1-hour averaging duration could require a permittee to collect several compliance samples during a 24-hour period. This additional burden is unnecessary since there is minor variability of the cadmium levels during a typical 24-hour period, and this additional monitoring is unwarranted without sound scientific basis.*	Please see response to above comment. While the criterion duration will now be expressed as one hour, WQBELs will continue to be expressed in terms of Maximum Daily and Average Monthly averaging periods. This is consistent with NPDES regulations at 40 CFR 122.45(d) and with WQBEL derivation procedures in EPA's TSD, as it has been applied to other chemicals that have acute aquatic life criteria expressed with a one-hour duration component. Changing the duration to one hour would therefore not have an effect on the expression of WQBELs or necessitate that additional samples be collected.	No edits

TOPIC 2: Comments regarding *H. azteca* test by Ingersoll is not acceptable; retest should be done or test should be removed from criteria development

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0007 and EPA HQ-OW-2015-0753-0008 (Illinois Environmental Protection Agency)	*The proposed chronic criterion is based on a flawed toxicity test (Ingersoll and Kemble 2001) conducted on the amphipod Hyalella azteca. The Hyalella test used in the criterion derivation should be repeated using current feeding procedures that are proven to result in better growth and reproduction. While the IEPA acknowledges and commends the improvements USEPA has made in the assessment and analysis of Hyalella sp. data compared to the 2001 cadmium criteria document, specifically in regards to the sensitivity of this organism to the presence/absence of chloride and bromide in culture and test water, the IEPA contends that the feeding regime employed in the 2000 USGS study is deficient by today's standards and likely resulted in malnourished, stressed test organisms.* *Specifically, test organisms in the 2000 USGS study were underfed and/or fed improper diets based on current research. Dr. Soucek, at the Illinois Natural History Survey, conducted new research that focused on determining the appropriate amounts of food for test organisms. His research has led to improved growth of test organisms compared to earlier diet regimes. The diet used in the 2000 USGS study consisted of a ration of 1.0 ml YCT/d, whereas Dr. Soucek's research contends that a diet consisting of Tetramin supplemented with diatoms greatly improves growth and reproduction of Hyalella azteca compared to YCT-only diets (Soucek et al. 2016, in press).* *The diet in the 2000 USGS study restricted growth and fecundity when compared to Tetramin-based diets (Soucek et al. 2016, in press), and brings into question the accuracy of the test results.*	While the results of the investigation by Soucek et al. (in press) suggest increased *H. azteca* growth and reproduction when diets of Tetramin are supplemented with diatoms or wheatgrass, compared to YCT, these results do not indicate a different level of *H. azteca* sensitivity to chemicals. Moreover, growth and reproduction for the Ingersoll and Kemble (2001) investigation are within the acceptable range based on current applicable guidelines. Average control growth (0.524 mg dw/individual after 42 days, as indicated by the regression equation) is acceptable based on applicable guidelines presented in ASTM (2005) ($\geq$ 0.15 mg dw/individual) and Environment Canada (2013) ($\geq$ 0.10 mg dw/individual), and as recommended by Mount and Hockett (Appendix K) ($\geq$ 0.50 mg dw/individual). Similarly, average control reproduction (6.4 young/female after 42 days) is acceptable based on applicable guidelines presented in ASTM (2005) (> 2 young/female) and as recommended by Mount and Hockett (Appendix K) ($\geq$ 6 young/female). The test by Ingersoll and Kemble (2001) is therefore considered to be acceptable for use in deriving the chronic criterion. Further, EPA's use of the Ingersoll and Kemble (2001) data reflects external peer reviewer recommendations that this specific study be used, as it represents the best available data for estimating cadmium toxicity to *H. azteca.*	No edits
EPA-HQ-OW-2015-0753-0007 and EPA HQ-OW-2015-0753-0008	*Test organisms in the 2000 USGS study did not attain minimum growth requirements based on the direct measure of organism weight, with the average dry weight of the controls being 0.27 mg/individual*	EPA communicated directly with the author of the 2000 USGS study, who indicated direct measures of weight were unreliable at the time the study was conducted, primarily due to the small weights of the organisms being measured. In contrast, length	No edits

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(Illinois Environmental Protection Agency)	*(<0.50 mg/individual). USEPA concluded that the dry weights measured in the test were inaccurate and subsequently used length data to extrapolate to dry weight via a regression equation. However there is no documentation provided for this equation or how it was derived. It is unlikely that the dry weights were underestimated (while an overestimation can be expected due to inadequate drying of test organisms), and it is therefore considered unlikely that the organisms achieved the minimum weight requirements for this test to be valid.*	measures had long been used by the lab and were determined to be accurate and reliable by the author at the time the study was conducted. The equation used to determine weight from length, and which was established by the same lab, has been used in multiple peer-reviewed publications (examples provided in Appendix A) and will be included in the forthcoming ASTM guidance for conducting tests with *H. azteca*. Provided below is a list of representative peer-reviewed publications using *H. azteca* length-to-weight regression in toxicity test results, indicating both the utility and acceptability of this approach. Besser JM, Brumbaugh WG, Ingersoll CG, Ivey CD, Kunz JL, Kemble NE, Schlekat CE, Garman ER. 2013. Chronic toxicity of nickel-spiked freshwater sediments: Variation in toxicity among eight invertebrate taxa and eight sediments. Environ. Toxicol. Chem. 32:2495-2506. Besser JM, Ingersoll CG, Brumbaugh WG, Kemble NE, May TW, Wang N, MacDonald DD, Roberts AD. 2015. Toxicity of sediments from lead-zinc mining areas to juvenile freshwater mussels (*Lampsilis siliquoidea*), compared to standard test organisms. Environ. Toxicol. Chem. 34:626-639. Besser JM, Ivey CD, Brumbaugh WG, Ingersoll CG. 2015. Effect of Diet Quality on Chronic Toxicity of Aqueous Lead to the Amphipod, *Hyalella azteca*. Environ. Toxicol. Chem. (in press) doi:10.1002/etc.3341 Ivey CD, Ingersoll CG. 2016. Influence of bromide on the performance of the amphipod *Hyalella azteca* in reconstituted waters. Environ. Toxicol. Chem. (in press) doi: 10.1002/etc.3421 Kemble NE, Hardesty DK, Ingersoll CG, Kunz JL, Sibley PK, Calhoun DL, Gilliom RJ, Kuivila KM, Nowell LH, Moran PW. 2013. Contaminants in stream sediments from seven U.S. metropolitan areas: II. Sediment toxicity to the amphipod *Hyalella azteca* and the midge *Chironomus dilutus*. Arch. Environ. Contam. Toxicol. 64:52-64.	

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EPA-HQ-OW-2015-0753-0007andEPA HQ-OW-2015-0753-0008 (Illinois Environmental Protection Agency)	*The dilution series (control and 5 treatment concentrations: 0.1, 0.3, 0.5, 2.0 and 3.0 μg/L.) used in the 2000 USGS test did not appropriately bracket the effect concentration. The dilution series was not standard, with a large gap in concentration between the NOEC and LOEC (0.5 and 2.0 μg/L, respectively). While a point estimation technique was used to determine the effect concentration, the lack of a 1.0 μg/L treatment may have changed this estimation. The precision of this estimation is paramount, as the test result was the sole determinant of the GMCV, which is the most sensitive in the chronic dataset, and a small change in the GMCV can therefore have a substantial effect on the final chronic value.*	When graphed with a response curve, the data indicate a break in the curve close to the 1.9 ppb treatment concentration. Dr. Mount and Dr. Hockett (EPA Duluth Lab) conducted a sensitivity analysis and determined that, because the curve breaks close to 1.9 ppb, the spacing of treatments between 0.51 ppb and 1.9 ppb would not have an appreciable effect on the calculated EC20.	No edits
EPA-HQ-OW-2015-0753-0007 and EPA HQ-OW-2015-0753-0008 (Illinois Environmental Protection Agency)	*At this time, the IEPA is in support of the adoption of the acute cadmium criterion as proposed, but is requesting a one year extension for the adoption of the chronic criterion. A one year extension would allow for a retest on Hyalella azteca using current feeding recommendations and would allow for revisions to be made to the chronic criterion. A round robin approach would ensure that the data are obtained using the appropriate test procedures and would provide additional information regarding the sensitivity of Hyalella azteca to cadmium. If time does not permit a repeat of the test, then the chronic criterion should be recalculated with the Hyalella data removed.*	EPA found that survival, growth, and reproduction in the USGS 2000 study is consistently acceptable based on current guidelines. Based on this and on the results of the additional detailed evaluation of the USGS study conducted by Dr. Mount and Dr. Hockett (EPA Duluth Lab) and Dr. Ingersoll (USGS), it was confirmed that the USGS study is acceptable for use in deriving the acute cadmium criterion. EPA has used the best available reliable data in the derivation of both the acute and chronic cadmium criteria.	No edits

TOPIC 3: Comments regarding dissolved vs total concentration use

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA HQ-OW-2015-0753-0005 (Florida Department of Environmental Protection)	*Additional documentation is needed to support the total to dissolved conversion factors. Very little information is provided concerning the derivation of the conversion factors, and more detailed information is needed to fully assess their appropriateness for natural waterbodies.*	Information has been added to the document to better describe the use of derived total to dissolved conversion factors. The acute freshwater conversion factors were determined empirically whereby total and dissolved cadmium concentrations were measured during 48- and 96-hour *Daphnia magna* and fathead minnow static toxicity tests conducted at different total hardness (TH) levels (Stephan 1996; University of Wisconsin – Superior 1995). Either cadmium chloride or cadmium sulfate were spiked in Lake Superior water and measured at test initiation and completion. The time weighted averages (TWA) obtained for percent dissolved cadmium for each simulation were used to determine the freshwater acute conversion factors of 0.973 at 50 mg/L TH, 0.944 at 100 mg/L TH and 0.915 at 200 mg/L TH. Freshwater chronic conversion factors obtained from the same tests and extrapolation procedures were 0.938, 0.909 and 0.880 at 50, 100 and 200 mg/L TH, respectively. The lower chronic conversion factors are due to the longer TWA period employed relative to the acute factors. The acute saltwater conversion factor of 0.99 determined by Lussier et al. (1999) was based on an *Americamysis bahia* 96-hr flow-through exposure and mean weighted total and dissolved cadmium concentrations. Narragansett Bay seawater was spiked with cadmium chloride and exposure concentrations were measured at 1- and 96-hrs.	Section 2.6
EPA HQ-OW-2015-0753-0005 (Florida Department of Environmental Protection)	*It is unknown if the solutions prepared from Cd salts, that were used to develop the conversion factors, adequately represent the forms of Cd found in natural waterbodies.*	Cadmium chloride and cadmium sulfate salts were used in the simulation tests, which are the same salts generally used in cadmium toxicity testing and typically found in the environment.	Section 2.6

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EPA HQ-OW-2015-0753-0005 (Florida Department of Environmental Protection)	*An explanation is needed as to why the conversion factors for the acute and chronic criteria are different. It also appears illogical that the constant conversion factor of 0.994 used for marine water is higher than for freshwater, especially because the hardness-dependent conversion factor for freshwater decreases as hardness increases.*	Information has been added to explain the difference between the acute and chronic conversion factors. The acute and chronic freshwater conversion factors were obtained from the same acute toxicity tests, with the only difference between the tests being the longer time weighted average (TWA) procedure applied to derive the chronic conversion factors relative to the acute factors. The freshwater and saltwater conversion factors are each based on dissolved-to-total ratios determined with toxicity tests using natural surface water. The only difference between the two is that the freshwater conversion factors were extrapolated using TWA procedures, whereas the saltwater conversion factor was based on mean weighted total and dissolved cadmium concentrations determined at test initiation and completion.	Section 2.6
EPA HQ-OW-2015-0753-0005 (Florida Department of Environmental Protection)	*While it is noted in several places in the document, clarify that the recommended criteria values are expressed as dissolved cadmium concentrations (not total). Also clarify if states have the option to adopt total Cd criteria values.*	EPA provides both dissolved and total concentrations for use by states and is maintaining both of these values in the final cadmium criteria document. However, EPA recommends the use of dissolved concentration, whenever possible, as it better represents the bioavailable fraction of cadmium in water.	No edits
EPA HQ-OW-2015-0753-0011	*Kansas has utilized the total recoverable metals criteria and data, and is not set up to sample for total dissolved metals. A conversion factor would be applied to calculate the dissolved concentration and Kansas recommends that EPA retain this flexibility in its final criteria.*	Please see response to previous comment.	No edits

TOPIC 4: Comments regarding data quality, use, and availability

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0006 (Kansas Department of Health and Environment)	*Some of the values that are new/revised since the 2001 AWQC document are from studies that were published before 2001. Table 22 has general information describing why GMAVs have changed between the 2001 and 2015 document, but it does not provide details on why these "new" data were now considered acceptable. Include another table that describes why the studies that were excluded previously are now included.*	The "new" acceptable data published prior to 2001 were never reviewed during the 2001 document update because the papers/reports were not available at that time. Acquisition of papers/reports during the 1999/2000 time frame was more difficult than currently available procedures, especially with present day enhanced internet capabilities. In some cases, data considered acceptable back in 2001 were deemed unacceptable during this update because more stringent acceptability criteria were implemented by EPA.	No edits
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*Should toxicity tests conducted under less-than optimal conditions be discounted? This comment goes beyond just the test results for Hyalella, because while laboratory tests used for criteria development use conditions that are as close to optimal as possible, wild populations in diverse natural conditions are often exposed to conditions that sub-optimal, and therefore laboratory tests may be underprotective in natural conditions (i.e., additional stresses) (see, Holmstrump et al. 2010; Besser et al. 2015).*	The acceptability of test results for inclusion in criteria development is currently based on the standards of acceptability established in the 1985 Guidelines and applicable testing protocols (e.g., ASTM).The list of studies considered acceptable for qualitative but not quantitative use in criteria derivation ("Other Data") are provided in Appendix H and I of the 2016 cadmium criteria document for freshwater and estuarine/marine tests, respectively. Tests that were not included in the quantitative evaluation were discussed, as appropriate, as part of the Effects Characterization (Section 5). The list of studies considered unacceptable for use in criteria development and the reason why they were not used are provided in Appendix J of the 2016 cadmium criteria document. EPA concurs there is a range of natural variables that will affect organism condition in the environment. However, the test acceptability methodology employed for the selection of studies used in criteria derivation ensures acceptable test quality and reduces the potential that test outcomes are affected by artifacts.	No edits
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*"Other data" are not addressed consistent with the Guidelines. While these data are not used in the species sensitivity distribution rankings, they should not be thrown away, discounted, or deemed "unacceptable." "Other Data" can be invoked to lower a criterion (e.g., chronic value in the 1987 selenium criterion). Revaluate Riddel et al. (2005a, b) and include a larger discussion of their effect concentrations/findings and other similar behavioral/ecological studies.*	These "Other data" are used qualitatively to support toxicity data compiled for existing species to derive the criteria. While some of these data may be used in characterization, data deemed unacceptable are not used in criteria derivation. The artificial stream study data from Riddel et al. (2005a, b) and Mebane et al. (2014) describing cadmium effect concentrations on behavior and predator-prey interactions have been added to Section 5.2 of the document.	Sections 5 and 5.2

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*With many organisms, a strong difference in the sensitivity of different life stages makes it inappropriate to roll up data from different developmental stages. Pooling salmonid effects concentrations across developmental stages to obtain a SMAV could produce a misleading result (see, Hansen et al. 2002; Mebane et al. 2012; Chapman 1978; Chapman and Stevens 1978).*	When a clear difference in the sensitivity of species is apparent across life stages then only the data for the most sensitive life stage is used to calculate the SMAV. The data in Appendix A and B were re-evaluated and the SMAV for rainbow trout and Chinook salmon were re-calculated using only the most sensitive life stages (i.e., smolts were not used in the SMAV calculation).	Appendix A Ranked FW Acute Table
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*The decision to only use ELS chronic data in which the exposures began in the egg stage, and to exclude long-term data in which the exposures began in the fry stage is non-conservative.*	This decision was based on previous external peer review comments. The use of the life cycle (LC) tests over the early life stage (ELS) tests in the draft reviewed by the external peer reviewers was consistent with the 1985 Guidelines. It was noted by the reviewer that for salmonids there was no consistent pattern of early life stage tests being more sensitive than life cycle tests. Based upon the peer reviewer comment, use of sensitive salmonid tests was reconsidered and changes in the approach were made for the 2015 draft criteria. Specifically, ELS tests were used to calculate the revised SMCV in instances where they were more sensitive than the LC tests (e.g., *Salmo trutta*). Therefore the most conservative test type was chosen for each species.	No edits
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*SMAV calculations tagged with the footnote "C", indicating that "Data not used to calculate SMAV because more sensitive life stage available, or flow-through measured test available", should be separated into two different footnotes since they are very different reasons.*	A footnote has been added to separate out "Data not used to calculate SMAV because more sensitive life stage available" from "flow-through measured test available".	Appendix A and Appendix B
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*Address the following Appendix A specific errors/changes:* • *Daphnia magna (various)* ○ *Many "S, U" tests (tests with unmeasured concentrations) are underlined, indicating they are included in the SMAV calculations. These should be excluded per the Guidelines.*	• Per the 1985 Guidelines (Section IV. I), acceptable static/unmeasured acute tests are only excluded from SMAV calculations when there is an acceptable flow-through/measured test available for the species. In addition, only for certain volatile or easily degraded contaminants (which cadmium is not) would static/unmeasured tests be considered for exclusion. Thus, if an acceptable flow-through/measured test is not available for *Daphnia magna*, then all acceptable acute data are used to calculate the SMAV for this species.	Appendix A Ranked FW Acute Table
	• *Mayfly (formerly, Ephemerella grandis) Drunella grandis* ○ *Tested species was listed in the source*	• Warnick and Bell (1969) did indeed conduct toxicity studies with *Ephemerella subvaria*, but Clubb et al. (1975) conducted tests with *Ephemerella grandis* (now classified as *Drunella*	

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	document as Ephemerella subvaria, which is still a valid species name according to ITIS.gov.	*grandis grandis*). These two tests were broken out in Appendix A, with the corrected name changes cited where appropriate.	
	• *Rainbow trout (smolt), Chapman 1975 (>2.9 μg/L)* ○ *Should be excluded from SMAV because it is from a resistant life stage. Also, should be listed as "Rainbow trout (Steelhead smolt)" as Steelhead are not just Rainbow Trout by a different name, but have physiological differences in regard to ion regulation. Chapman (1975) should only be cited when no alternative exists, because it was never formally released by EPA and is not publicly available online. Chapman (1978) reports the same data and is a better citation.* • *Rainbow trout (smolt), Chapman 1975 (4.1 μg/L)* ○ *Suspect value, exclude from SMAV. Chapman (1978) lists the value for the same test as >2.9 μg/L. Chapman (1978) is the peer-reviewed publication of record for these data; Chapman (1975) was an unpublished, work-in-progress progress report that sometimes still gets cited because it includes data never published elsewhere, such as the coho data shown in the figure in this memo. Exclude from SMAV, resistant life stage and re-label as " "Rainbow trout (Steelhead smolt". See Chapman (1978, Table 3).*	• The Chapman (1975) unpublished report data were deleted from the appropriate tables, based on indication by the author that the published paper (i.e., Chapman 1978) superseded the report. Further, the value for the smolt was removed from the calculation of the SMAV for rainbow trout because it is a more resistant life stage. Studies were grouped by scientific name for evaluation, and were not differentiated based on functional characteristic.	
	• *Rainbow trout (299 mg), Stratus (1.29 μg/L)* ○ *Exclude from SMAV; pH was manipulated (lowered to 6.5) and matched tests with unmanipulated pH of 7.5 were much more sensitive*	• The pH manipulated value from Stratus Consulting (1999) for the rainbow trout is appropriate to use since it is within the pH range for permitted outfalls (6.5-9.0) and is within the range of pH found in ambient surface waters. Thus the test conducted at pH 6.5 reflects the natural environment and should be included in the database.	
	• *Chinook salmon (parr, 11.58g) (3.5 μg/L)* ○ *Exclude value from SMAV, based on a resistant life stage being tested. Value is*	• The Chinook salmon values for the parr and the smolt were removed from the SMAV calculation because they are from a more resistant life stage.	

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	twice as high as the value obtained with swim-up fry in matched tests and confidence limits don't overlap. • *Chinook salmon (smolt, 32.46 g) (>2.9 μg/L)* ○ *Should be excluded from SMAV, based on a resistant life stage being tested.*		
	• *Bull trout (84.2 mg) (2.89 μg/L)* ○ *Exclude from SMAV; pH was manipulated (lowered to 6.5) and matched tests with a natural pH of 7.5 were much more sensitive*	• The pH manipulated value from Stratus Consulting (1999) for the bull trout is appropriate to use since it is within the pH range for permitted outfalls (6.5-9.0) and is within the range of pH found in ambient surface waters. Thus the test conducted at pH 6.5 reflects the natural environment and should be included in the database.	
	• *Colorado squawfish* ○ *Old common name is now considered repugnant. AFS calls it "Colorado pikeminnow". "Pikeminnow" is one word.*	• The Colorado squawfish common name was changed to Colorado pikeminnow.	
EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*Address the following Appendix C specific errors/changes:* • *Snail, Aplexa hyporum (Holcombe) (4.0 μg/L)* ○ *I got an EC20 of about 2.6 μg/L. By excluding the highest treatment with total mortality I could reproduce the 4.0 EC20 value, but it had a poor fit with Y0.*	Two separate EC_{20}s for Holcombe et al. (1984) were calculated: 1) an un-normalized EC_{20} of 4.002 μg/L based on the number of egg masses per snail for tanks A and B, and 2) an un-normalized EC_{20} of 0.8737 μg/L based on survivors to test end for tanks C and D. The EC_{20} of 4.002 μg/L was calculated using the threshold sigmoid model in TRAP version 1.21 (and was replicated in TRAP version 1.30 with the same result) using the following initial parameters: log X_{50} = 0.7, S=2, y-intercept=90. No treatments were excluded (treatments with 100% mortality were treated as having 0 egg masses/snail). If test data from tanks A and B are combined with data from tanks C and D, the un-normalized EC_{20} for egg-masses per snail was calculated as 2.515 μg/L, using a threshold sigmoid model in TRAP version 1.30. This was the only method where EPA was able to calculate an EC_{20} similar to 2.6 μg/L. The present method of calculation (two EC_{20}s of 4.002 and 0.8737 μg/L, respectively) results in a similar (un-normalized geometric EC_{20} of 1.870 μg/L), but slightly more conservative value for *Aplexa* than the un-normalized 2.515 μg/L that would be obtained for the number of egg masses per snail by combining data from tanks A-D.	No edits

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EPA-HQ-OW-2015-0753-0013 (Chris Mebane, US Geological Survey)	*Add the following additional relevant data:*
	• *Pascoe and Mattey 1977*
	  ○ *Chronic stickleback exposure*
	• *Wang et al. 2014*
	  ○ *Chronic fathead full life-cycle test*
	• *Brinkman and Vieira 2008*
	  ○ *Acute and chronic mountain whitefish*
	• *Mebane et al. 2014 (paper provided)*
	  ○ *Effects of cadmium on larval aquatic insect communities in 30-day experimental stream tests*
		• Pascoe and Mattey 1977
		  ○ Study was deemed unusable because of: 1) no control information and 2) dilution water was not defined (appears to be reconstituted water).
		• Wang et al. 2014
		  ○ Study was deemed unusable because of: 1) only three exposure concentrations, 2) a static chronic exposure (should be static-renewal or flow-through) and 3) only a 21-day fish test (should be at least 28 days).
		• Brinkman and Vieira 2008
		  ○ Consistent with 1985 Guidelines, the study was deemed unusable because scientific name was not given (only common name given).
		  ○ Further, elevated cadmium concentrations were measured in controls.
		  ○ Additionally, for the Early Life Stage tests, temperature measurement did not follow ATSM guidance.
		• Mebane et al. 2014
		  ○ Initial review of preliminary summary shows 32-day effects levels at 0.1-0.8 µg/L Cd. However the natural river water used for dilution is only partially characterized.
			Mebane et al. (2014) added to Section 5.2

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0014 (Center for Biological Diversity)	*There is concern about the focus on fish in developing the criteria. EPA needs to bring in other species including insects and freshwater mussels into the process when developing criteria for cadmium. This lack of additional species prevents a more holistic picture of the freshwater community, and results in criteria that are not protective of all aquatic-dependent wildlife. EPA has consistently failed to fully consider aquatic-dependent wildlife in the development of national criteria.*	The 1985 Guidelines requires acceptable data to be available for at least eight genera with a specified taxonomic diversity, which is the standard eight-family minimum data requirement (MDR). The purpose of the eight-family MDR is to serve as a surrogate sample community representative of the larger and typically much more diverse natural aquatic community, which includes aquatic invertebrates and extends well beyond the protection of fish. In fact, five of the 8 MDRs are for invertebrates, not fish. Data were available to meet these MDRs for freshwater acute and chronic criteria and for the estuarine/marine acute criterion. Table 5 was revised in the final criteria document to more clearly summarize species included as part of the MDRs. As discussed in Section 2.3 of the criteria document, mammals and avian wildlife could be exposed to cadmium in abiotic media while foraging in aquatic habitats or via the ingestion of prey that have bioaccumulated cadmium from the aquatic environment. However, freshwater biota are considered to be the most sensitive to cadmium. Marine organisms are generally considered to be more resistant than freshwater organisms, while mammals and birds are considered to be comparatively resistant to cadmium (Burger 2007; Eisler 1985). Based on these observations, criteria that are protective of aquatic life are also considered to be protective of mammalian and avian wildlife (including aquatic-dependent wildlife) and aquatic life were therefore the focus of the evaluation.	No edits
EPA-HQ-OW-2015-0753-0010 (Hampton Roads Sanitation District)	*There is concern with the continued lack of estuarine/marine chronic cadmium toxicity data and that no new chronic toxicity data have been generated since 2001. EPA should conduct additional chronic toxicity studies (particularly with vertebrate species) to expand the estuarine/marine chronic toxicity dataset. More estuarine/marine chronic data are needed to develop a scientifically reliable chronic cadmium criterion.*	Chronic data on estuarine/marine species are extremely limited. For this reason, ACRs were derived using the robust acute estuarine/marine database and consistent with the 1985 Guidelines to support derivation of the estuarine/marine chronic value. EPA agrees that generation of additional estuarine/marine chronic toxicity data for cadmium by the scientific community would be desirable.	No edits

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0010 (Hampton Roads Sanitation District)	*The mysid Neomysis integer is a new species added to the estuarine/marine acute dataset, but this mysid is potentially non-native to the United States. Since there are available values for two other native mysid species (M. bigelowi and A. bahia), this non-native species should be removed (unless documentation is provided confirming it is naturally occurring within waters of North America).*	*Neomysis integer* has been removed from the database since it is not occurring within waters of North America. In addition, a new North American estuarine/marine species, *Neomysis americana*, has been added to the database after obtaining a new paper (i.e., Roberts et al. 1982), thus potential use of the non-native species as a surrogate for other mysids is unnecessary.	Section 3.2.1 and Appendix B

TOPIC 5: Comments regarding ESA considerations

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0014 (Center for Biological Diversity)	*EPA must ensure that any criteria ("Action") that it recommends to states for adoption will be fully protective of listed species. The federal act of establishing criteria has both direct and indirect effects for listed species. Therefore Section 7 consultations would be beneficial since there are several areas where peer reviewers and the EPA disagree (i.e., bioaccumulation, data used in the hardness correction, and incorporation of the BLM). Involvement of biologists from the Services could benefit the resolution of these and other issues. Furthermore, the language in the Endangered Species Act ("ESA") states that EPA must consult the Services in its recommendations of the criteria.*	EPA disagrees that before making general recommendations to states regarding future state actions to adopt cadmium criteria ("national recommendations"), it is helpful or legally necessary to first engage in consultation under the ESA to ensure that any possible subsequent federal action to approve new or revised state cadmium criteria consistent with the national recommendations would necessarily be protective of listed species. The issuance of national criteria recommendations for cadmium does not impose any legally binding requirements on states. Nor does it authorize any state or federal action that would otherwise be inconsistent with the ESA, simply on the grounds that such action is consistent with EPA's national recommendations under the Clean Water Act. Since the distribution of listed species which might affect the appropriate water quality criteria is location-specific, and the national recommendations for cadmium are intended to be generally informative, allowing the most sensitive location-specific potential concerns to drive national recommendations would tend to inappropriately distort those recommendations. EPA believes that national-level efforts to consult on potential future approvals of new and revised state cadmium criteria would be neither efficient, likely to ensure a consistent approach to evaluating the effects of pollutants on species, nor necessary to address the effects of action on species whose ranges cross state boundaries: (1) It would be inefficient because it would tend to produce national criteria recommendations for cadmium that states would need to modify to make less stringent before incorporating into their own standards, based on the absence of species-specific concerns. EPA believes that it is more efficient for states to modify national criteria recommendations for cadmium to make them more stringent, as needed based on the presence of localized species-specific concerns. (2) It is unlikely to ensure a consistent approach because the Services have indicated that national consultation on recommended cadmium criteria would not obviate the need for further consultation at the Service field office level, on subsequent federal actions to approve particular new or revised state water quality criteria for cadmium. Any gains in consistency from an initial national consultation are likely to be undone by inconsistencies among the follow-up consultations at the field office level. (3) National consultation is unnecessary to adequately	No edits

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
		address concerns about trans-boundary movement of cadmium or organisms because when ESA consultation occurs on the proposed approval of a state's new or revised cadmium criteria, there is no bar to considering pertinent effects on species outside the state's jurisdiction. Such effects may be relevant for a number of reasons, including that EPA requires each state to take into consideration the water quality standards of downstream waters when setting its own criteria. 40 CFR 131.10(b). Irrespective of these national 304(a) recommendations, EPA intends to consult with the Services about a proposed approval of a state water quality standard under Clean Water Act Section 303(c), before undertaking the Federal action of approving, to the extent that it determines that such approval may affect listed species.	
EPA-HQ-OW-2015-0753-0014 (Center for Biological Diversity)	*To ensure the final cadmium water quality criteria is fully protective of all types of wildlife, EPA should engage the Fish and Wildlife Services (FWS) broadly (not just as is legally required by the ESA) and include other divisions of the FWS that may have additional expertise and information that would be beneficial to the EPA.* *Congress expected that EPA would engage with the FWS and other federal agencies when developing criteria. This engagement does not need to be burdensome or formalistic. The Fish and Wildlife Coordination Act (FWCA) can be used as a framework to achieve this coordination and strengthen the final recommended criteria.*	EPA acknowledges that FWS strives to ensure that inter-agency consultation is neither burdensome nor formalistic. Nonetheless, for the reasons described above, consultation on these non-binding national 304(a) criteria recommendations is neither necessary nor helpful. EPA disagrees with FWS' suggestion that the FWCA would be a useful coordination framework for discussing national criteria recommendations under CWA § 304(a) and notes that the suggestion appears to be premised on a misunderstanding of the Clean Water Act. The FWCA relates to circumstances in which it is "proposed or authorized" that certain waters be "impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose." 16 U.S.C. § 662. In communicating national criteria recommendations to the public, EPA is neither proposing nor authorizing any modification of any water body.	No edits
EPA HQ-OW-2015-0753-0009 (California State Water Resources Control Board)	*The NMFS and FWS Final Biological Opinion for the State of Oregon's adoption of the previous AWQC cadmium criteria (2001) and USEPA's disapproval of the acute criterion required the State to develop replacement criteria based on:* *1. Only using toxicity data for cadmium that was specific to salmonid fishes, and green sturgeon and eulachon, if available* *2. Curve-fitting all toxicity data used to derive the numeric criterion*	The NMFS and FWS (referred to here as the Services) Biological Opinions were developed for the state of Oregon's Water Quality Standard, not the 2001 national 304(a) criteria, nor the draft 2016 national 304(a) updated criteria, which are recommendations that were developed per EPA's Guidelines for National Aquatic Life Criteria (Stephan et al, 1985). The commenter confuses the Reasonable and Prudent Alternatives expressed in NMFS' biological opinion with the remedies stated in EPA's Clean Water Act disapproval of the state water quality	No edits

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
	3. *Extrapolating threshold acute and chronic toxic effect concentrations using the curve-fitted data* 4. *Adjusting derived criteria to ac7count for chemical mixtures* 5. *Using a population model that integrates the derived criteria to predict no negative change in each species population's intrinsic growth rate* *These requirements were not applied to the new draft recommended criteria and the new acute value is greater than the previous recommendation. Since California shares similar ESA species populations to those in Oregon, the NMFS biological opinion must be considered. Furthermore, since the previous lower acute value resulted in a jeopardy decision, it is likely the new higher criteria will not be viewed favorably.*	standard. Not one of the requirements listed by the commenter was actually imposed by EPA on the State of Oregon in its January 30, 2013 disapproval of the Oregon acute criterion for cadmium. The NMFS biological opinion found that exposure to cadmium at levels equivalent to the acute cadmium criterion values adopted by Oregon would jeopardize the continued existence of some of the endangered species under its jurisdiction and therefore the opinion included Reasonable and Prudent Alternatives (as summarized in the comment) to remedy the jeopardy decision. The final biological opinion from FWS did not find that the acute cadmium criterion would result in jeopardy of the listed species under its jurisdiction and did not contain the Reasonable and Prudent Alternatives summarized by the commenter. Because EPA is developing a federal rulemaking for Oregon to resolve EPA's 2013 disapproval of Oregon's acute cadmium criterion, EPA has conducted additional analyses, consistent with the Reasonable and Prudent Alternatives contained in the NMFS opinion, on the updated 2016 acute cadmium criterion magnitude relative to salmonid species of concern in Oregon. EPA notes that available salmonid "curve-fitted data" indicate that mean minimal salmonid effect levels specified by NMFS in the opinion occur at concentrations slightly higher than the national acute criterion recommendation or water quality standard based on this recommendation. EPA is conducting further analyses on potential mixture effects based on available data and results indicate protection from mixture combinations specified by NMFS at the cadmium acute criterion magnitude. EPA is also examining population modeling recommendations made in the NMFS Biological Opinion, in concert with the NMFS. Finally, EPA notes that additional protection is expected because the acute criterion duration is specified to be a one-hour duration, and the frequency recommendation is that the one-hour concentration not be exceeded more than once in 3 years on average. . The 2001 acute criterion for which the NMFS biological opinion was developed recommends a 24-hour duration. Therefore, the 2016 cadmium acute criterion duration provides an added level of protection for these species of concern, in addition to the protective magnitude through the use of a one-hour duration	

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA HQ-OW-2015-0753-0009 (California State Water Resources Control Board)	*The new chronic criterion also presents a similar challenge, since it is higher than the criterion in the FWS and NMFS biological opinions. The 2015 draft recommended criteria are not sufficiently protective of ESA species in California.*	Please see response to the above comments. At such time as EPA reviews specific new or revised aquatic life water quality criteria for cadmium in California under Clean Water Act Section 303(c), EPA intends to consult with the Services about any proposed approval, to the extent that EPA determines that such approval may affect listed species.	No edits
EPA HQ-OW-2015-0753-0015 (National Marine Fisheries Service)	*EPA needs to work with the NMFS to conduct a more thoughtful evaluation of the implications of their guidelines methodology for criteria development for ESA listed species, especially in context of the limited data available for ESA-listed species. Comments on the prior ESA Section 7 Consultation with NMFS are included as attachments (multiple attachments).* *EPA's approach to addressing obligations under ESA (ESA consultation when agency approves state-proposed criteria) leads to a piecemeal approach, particularly for broadly-ranging species. Given the scope of the guidelines, the conclusions of such an assessment and any associated implementation guidance would need to have the same authority/regulatory implications of a Section 7 Consultation.*	Thank you for your comment. Please see response to comment EPA-HQ-OW-2015-0753-0014.	No edits
EPA HQ-OW-2015-0753-0015 (National Marine Fisheries Service)	*''EPA's freshwater acute guideline is slightly above Oregon's proposed criterion of 2.0 µg/L. It was determined that the proposed 2.0 µg/L criterion would jeopardize the continued existence of ESA-listed species occurring in that state. Several of the 96 hour LC50 values for the ESA-listed species used in the derivation of the Oregon standard are below the criterion, so these data were used to evaluate the implications on population growth rates. The analyses identified cases where population growth rates would be significantly altered based on exposure to 2.0 µg/L cadmium (see NMFS Attachment 4).* *EPA's chronic freshwater guideline for cadmium is also higher than the chronic criterion proposed by Oregon (0.73 µg/L vs 0.25 µg/L). NMFS analyses indicated exposure to 0.25 µg/L cadmium would result in sublethal effects, but the effects did not rise to the*	Please note the final 2016 acute freshwater criterion has been revised to 1.8 µg/L from 2.1 µg/L in the 2015 public review draft document based on minor changes to the salmonid dataset. Updated acute and chronic 304(a) national cadmium criteria recommendations are based on a robust dataset that included 101 and 27 species, respectively. These data reflect the best available science, and include consideration of all available, quality tests on endangered species. As is true for all criteria, if data are available for endangered or other sensitive species that may be present in a state, state water quality standards can be developed to protect species present. CWA Section 304(a) water quality criteria pertaining to the protection of aquatic life include three components, magnitude, frequency, and duration, which function together to provide protection to aquatic life. Duration components of the cadmium criteria reflect periods of time that are substantially shorter than the	No edits

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
	level of jeopardy. EPA's 0.73µg/L guideline is nearly three-fold Oregon's criterion and would be expected to result in more severe effects. *Idaho's proposed (2006) acute and chronic freshwater criteria of 1.3 and 0.6 µg/L, respectively, and a NMFS analysis of these criteria determined they were not likely to adversely affect Idaho's ESA-listed salmonids under NMFS jurisdiction (see NMFS Attachment 5). However, criteria applied elsewhere would still require an analysis incorporating location-specific considerations.*	lengths of toxicity tests used to derive criteria. Accordingly, duration components provide additional protection beyond the criteria magnitude. The frequency aspect of criteria provides additional protection, in that criteria magnitudes are recommended not to be exceeded more than once in 3 years on average. Regarding the chronic criterion, the cadmium chronic criterion duration is specified as 4 days, and is based on effects observed in chronic tests following exposures to cadmium that range from approximately 3 weeks to 6 weeks in duration. Thus, the cadmium criterion chronic duration is expected to provide additional protection to aquatic species. The chronic criterion also cannot be exceeded more than once in 3 years on average. Population modeling to assess potential chronic effects should necessarily incorporate not just the magnitude, but the duration and frequency aspects of criteria in order to provide robust predictions of any projected population level effects.	
EPA HQ-OW-2015-0753-0015 (National Marine Fisheries Service)	*While the Oregon consultation concluded that ESA-listed sea turtles would be unlikely to accumulate a significant amount of cadmium from state waters, the draft cadmium guidelines apply to all waters of the US, so exposures would occur throughout the US portion of a sea turtle's range. Cadmium accumulates in tissue with age and sea turtles are long lived species (20-50 years). For long lived species, it needs to be determined if cadmium accumulation from US waters over a lifespan would reach tissue concentrations resulting in or contributing to adverse effects. Dietary exposure of the more omnivorous sea turtle species (i.e., leatherback, loggerhead) are of particular concern.*	Data on estuarine/marine species, particularly chronic data, are extremely limited. Data on longer-lived species also remain a data gap for both EPA and other federal partners. As discussed in the criteria document, based on available data cadmium is unlikely to accumulate to levels that would result in adverse effects to aquatic invertebrates, fish, or wildlife from the ingestion of aquatic life that have accumulated cadmium in their tissues.	No edits
EPA HQ-OW-2015-0753-0015 (National Marine Fisheries Service)	*There is a concern about the lack of data for the effects of cadmium on smalltooth sawfish and Atlantic, Gulf, or shortnose sturgeon species, and that ambient aquatic exposures alone would be inadequate to assess effects to ESA-listed species. These are long-lived species (>20 years) that are known to ingest sediment (which may include particulate-bound cadmium originating from the water column) with their benthic prey.*	EPA agrees that there is a lack of empirical data for listed species. As discussed in the criteria document, based on available data, cadmium is unlikely to accumulate to levels that would result in adverse effects to aquatic invertebrates, fish, or wildlife from the ingestion of aquatic life that have accumulated cadmium in their tissues. Most aquatic organisms are considered to be more susceptible to cadmium from direct aqueous exposure than through bioaccumulation and direct exposure effects are considered more applicable to the development of criteria protective of aquatic life.	No edits

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA HQ-OW-2015-0753-0015 (National Marine Fisheries Service)	*While the limited data (see, Reichelt-Brushett and Harrison 2005; Mitchelmore et al. 2007; Howe et al. 2014) suggest that the EPA guidelines for cadmium in marine waters are protective of coral species, the certainty of this conclusion is limited by the absence of data on colonization and recruitment, wound recovery, and predation activity.*	There were no data available for coral species for EPA to consider. It is noteworthy that that criteria recommendations include components that increase the protection afforded aquatic species through limitations on exposure duration and frequency, in addition to magnitude (concentration) (see comment #: *EPA HQ-OW*-2015-0753-0015II). These aspects of criteria provide additional levels of protection to aquatic life, particularly if data suggest that the magnitudes of the updated cadmium criteria are protective.	No edits

TOPIC 6: Other comments

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0014 (Center for Biological Diversity)	*In the description of sources of cadmium in the document, EPA overlooked the contribution from coal combustion, coal mining waste, and coal ash ponds spills, seepage, and discharge. These important sources need to be recognized and addressed.*	Additional available information has been added to the document detailing the anthropogenic sources of cadmium from coal ash ponds/pits.	Section 2.1

EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*Check the document for errors and typos. Specific examples include:*
	• *Pg.27 which is intended to provide an acute criterion protective of nearly all individuals in the distribution (Stephan et al. **1985);the** FAV/2 approach was developed to estimate minimal effect levels,*
	• *Pg.30 This outcome was based on the poor correlation between hardness and acute toxicity for D. magna and occurred only when tests with **less than** 24-hr old neonates were included in the database. Accordingly, only the five D. magna tests from Chapman et al. (1980} initiated with **less than** 24-hr old neonates were used for the analysis*
	• *Pg.33 Two species of sculpin, Cottus bairdii and Cottus confusus, are used to derive the normalized GMAV of **4.962** µg Cd/L*
	  ○ ***Per Appendix A, this value should be 4.926***
	• *Pg.34 The hardness-normalized GMAV of **7.911** µg/L total cadmium for the genus Oncorhynchus is the fifth lowest in the acute dataset*
	  ○ ***Per Appendix A, this value should be 7.841 ***
	• *Pg.42 2. Ceriodaphnia, Cladoceran (GMCV=**1.293µg/l** total Cd)*
	• *Pg. 74 Acceptable chronic toxicity **data** are available for 27 freshwater species representing 20 different genera*
	• *Pg. C-8 [d] Not used to calculate **SMAV** because either a more definitive value available, value is considered an outlier, or preference was given to the more sensitive exposure scenario (LC versus ELS tests).*
		The document was thoroughly reviewed prior to Federal Register publication. Typos and grammatical errors have been corrected and suggestions highlighted in your comments have been addressed.	Various locations

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*While Table 5 summarizes the Phyla, Families, Genera, and Species used to derive the revised criterion, it is unclear which species were used to meet each of the MDRs. Include a table that lists the eight requirements and the species used to fulfill them.*	Table 5 has been modified to include the genus used to fulfill each of the family MDRs.	Table 5
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*Verify that the Spehar and Fiandt 1986 data for Pimephales promelas is appropriate to include in the freshwater acute hardness correction.*	The Spehar and Fiandt (1986) data for *Pimephales promelas* satisfy the requirements for use in the freshwater acute slope derivation, and although the acute value for this study is lower than the other data evaluated at a similar hardness level, there is no justification for exclusion. Additional tables were added to Appendices A and C to list which studies and values were used in the respective hardness normalization analysis.	Appendix Table A-1, A-2, C-1 and C-2
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*Expand Table 6 to include the actual data that were used in the freshwater acute hardness correction for each species.*	An additional table was added to Appendix A to list which studies and values were used in the hardness normalization analysis.	Appendix Table A-2
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*Include a graph showing the freshwater acute hardness linear regression to better illustrate the normalization process.*	A graph has been added showing the freshwater acute hardness linear regression to better illustrate the normalization process.	Figure 2

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0006 Wisconsin Department of Natural Resources)	*Indicate how the R^2 value of 0.964 was obtained in the freshwater acute hardness correction. Attempts to replicate the value resulted in a slope of 1.104 and R^2 of 0.698.* *Indicate how the R^2 value of 0.841 was obtained in the freshwater chronic hardness correction. Attempts to replicate the value resulted in a slope of 0.798 and R^2 of 0.632.*	The differences in r^2 for both the acute and chronic hardness correction slopes represents differences in the models used to calculate these slopes. While the commenter manually normalized log transformed hardness and toxicity values by species prior to the regression (inferred from Figure 1 and 2), the draft document did not manually normalize to species, but rather used the following multiple linear regression model: lnToxicity = Species + lnHardness; Where "lnToxicity" represents either ln transformed acute or chronic toxicity values, as applicable. The inclusion of a "Species" term in a multiple regression model prior to the lnHardness term returns a normalized hardness slope without having to manually normalize data to species, as shown by the equivalent hardness slopes calculated using the two approaches. The higher r^2 in the multiple regression model is due to the inclusion of the species term, as the effects of species are also accounted for in the model, but the hardness slopes are equivalent. This is the same approach used in the previous (2001) cadmium criteria document.	No edits
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*It was not apparent if the MATC or EC_{20} value was used for the freshwater chronic slope derivation. Indicate which of the toxicity values were used in the derivation in Appendix C and Table 8.*	A table was added to Appendix C to list which studies, effect measurement and values were used in the hardness normalization analysis.	Appendix Table C-2
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*Include a graph showing the freshwater chronic hardness linear regression to better illustrate the normalization process.*	A graph has been added showing the freshwater chronic hardness linear regression to better illustrate the normalization process.	Figure 4
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*The language that describes the computation of the final acute value on pg. 32 is insufficient. Include a reference to section 4.3.1 after the reference to Figure 2 on page 32.*	Reference to Section 4.3.1 has been added.	Section 3.1.1

Comment Number	Public Comment	EPA Response	Revision Location in 2016 Cadmium Criteria Document
EPA-HQ-OW-2015-0753-0006 (Wisconsin Department of Natural Resources)	*It is unclear how the intercept of the freshwater acute and chronic criterion equations were derived. Add additional language to clarify how these values were derived.*	The intercept and slope of the freshwater acute and chronic criterion equations were derived based on an analysis of the data as described in section 3.1.1 for acute freshwater, and section 3.1.2 for chronic freshwater criteria. The intercepts can be calculated by rearranging the criterion equations for total cadmium and solving for the intercept. The constants/intercept in the equations for the CMC and CCC were derived as follows: The total cadmium CMC= $e^{(0.9789 \text{ x } \ln(\text{hardness}) - 3.866)}$ Where, 0.9789 is the acute pooled slope and -3.866 is calculated as =ln(CMC at 100 hardness) - (Pooled Acute Slope x (ln(100))) =ln(1.9)-(0.9789 x 4.605) The dissolved cadmium CMC can be calculated by multiplying the total cadmium CMC by a conversion factor, CF Acute CF= 1.136672 - [(ln hardness) x (0.041838)] Similarly, the total cadmium CCC = $e^{(0.7977 \text{ x } \ln(\text{hardness}) - 3.909)}$ Where, 0.7977 is the chronic pooled slope and; -3.909 is calculated as =ln(CCC at 100 hardness) - (Pooled Chronic Slope x (ln(100))) =ln(0.79)-(0.7977 x 4.605) The chronic total-to-dissolved CF = 1.101672 - [(ln hardness) x (0.041838)]	No edits