The Indiana Department of Environmental Management (IDEM) is soliciting public comment on its intent to revise Indiana's aquatic life and human health ambient water quality criteria (WQC) for select metals currently at 327 IAC 2-1-6 and 327 IAC 2-1.5-8. Revisions to criteria reflect updates based on current science and many are National Recommended Water Quality Criteria (NRWQC) at Section 304(a) of the Clean Water Act (CWA). IDEM is proposing these revisions in order to remain consistent with state and federal laws and to ensure that Indiana's WQC for metals continue to reflect the best available science and support sound water quality management policies to improve and protect the water resources of the state. Based on the latest scientific knowledge, updated aquatic life and human health ambient WQC for these metals may become more or less stringent than current criteria.

For the First Notice of Comment Period, IDEM provided tables showing proposed criteria revisions. For the Second Notice of Comment Period, IDEM is providing updated criteria tables along with comments to help explain some of the changes made to the First Notice tables. When applicable, the comments include information regarding the stringency of the proposed criteria relative to current criteria.

With the exception of selenium, aquatic life criteria for metals are expressed in terms of either total recoverable metal or dissolved metal in the water column. For those metals expressed in terms of dissolved metal in the water column, the water quality criterion is calculated by multiplying the aquatic life criterion, which is expressed in terms of total recoverable metal, by a conversion factor.

In the Second Notice of Comment Period, IDEM is proposing to adopt USEPA 2016 NRWQC for cadmium and selenium. The updated criteria reflect best available science and will support water quality management practices to improve and protect water resources of the state. For selenium, the latest scientific knowledge indicates that toxicity to aquatic life is primarily based on organisms consuming selenium-contaminated food rather than from being exposed only to selenium dissolved in water. The NRWQC is expressed both in terms of fish tissue concentration (egg/ovary, whole body, muscle) and water column concentration (lentic, lotic).

Proposed revisions to aquatic life WQC are presented in Tables 1A, 1B and 1C for waters outside of the Great Lakes system and in Tables 2A and 2B for waters within the Great Lakes system. Proposed revisions to human health WQC for waters outside of the Great Lakes system are presented in Tables 3A and 3B. IDEM does not propose to change any human health WQC for waters within the Great Lakes system.

Table 1A: Water quality criteria for the protection of aquatic life for waters outside of the Great Lakes system.

Metal[1]	Current Aquatic Life Criteria (µg/L)		Proposed Aquatic Life Criteria (µg/L)		Comments
	Acute	Chronic	Acute	Chronic	
Aluminum (Total Recoverable)	No current criterion	No current criterion	$e^{(1.3695\ [\ln(\text{hardness})]+1.8308)}$	$e^{(1.3695\ [\ln(\text{hardness})]+0.9161)}$	USEPA's current acute and chronic NRWQC are 750 and 87 µg/L, respectively. The proposed equations are based on New Mexico's current criteria which are also applicable to Indiana's waters. These are hardness-based criteria, and the equations only apply within a pH range of 6.5 and 9.0.
Arsenic (Dissolved)	360 X 1.000	190 X 1.000	340 X 1.000	150 X 1.000	Changed from Arsenic (III) to Total Arsenic and rounded to 2 significant digits in Second Notice. Proposed criteria are more stringent than current criteria.
Cadmium (Dissolved)	$(e^{(1.128\ [\ln(\text{hardness})]-3.828)})$ X 1.136672-[(ln hardness)(0.041838)]	$(e^{(0.7852\ [\ln(\text{hardness})]-3.490)})$ X 1.101672-[(ln hardness)(0.041838)]	$(e^{(0.9789\ [\ln(\text{hardness})]-3.866)})$ X 1.136672-[(ln hardness)(0.041838)]	$(e^{(0.7977\ [\ln(\text{hardness})]-3.909)})$ X 1.101672-[(ln hardness)(0.041838)]	Proposed criteria in First Notice replaced with USEPA 2016 NRWQC. Proposed criteria are more stringent than current criteria.
Chromium (III) (Dissolved)	$(e^{(0.819\ [\ln(\text{hardness})]+3.688)})$ X 0.316	$(e^{(0.8190\ [\ln(\text{hardness})]+1.561)})$ X 0.860	$(e^{(0.819\ [\ln(\text{hardness})]+3.7256)})$ X 0.316	$(e^{(0.819\ [\ln(\text{hardness})]+0.6848)})$ X 0.860	No change, same as First Notice. Proposed acute criterion is less stringent than current criterion; proposed chronic criterion is more stringent than current criterion.
Chromium (VI) (Dissolved)	16 X 0.982	11 X 0.962	16X 0.982	11X 0.962	Current criteria retained.
Copper (Dissolved)	$(e^{(0.9422\ [\ln(\text{hardness})]-1.464)})$ X 0.960	$(e^{(0.8545\ [\ln(\text{hardness})]-1.465)})$ X 0.960	$(e^{(0.9422\ [\ln(\text{hardness})]-1.700)})$ X 0.960	$(e^{(0.8545\ [\ln(\text{hardness})]-1.702)})$ X 0.960	No change, same as First Notice. Proposed criteria are more stringent than current criteria.

[1] For those metals expressed in terms of dissolved metal in the water column, the water quality criterion is calculated by multiplying the aquatic life criterion, which is expressed in terms of total recoverable metal, by a conversion factor. The equation for this calculation is shown on the table.
With the exception of aluminum, the equations can be used to calculate numeric criteria at any water hardness up to 400 mg/L $CaCO_3$. The criteria at a water hardness of 400 mg/L $CaCO_3$ are used for water hardnesses above 400 mg/L $CaCO_3$. For aluminum, the water hardness is capped at 220 mg/L. The criteria at a water hardness of 220 mg/L $CaCO_3$ are used for water hardnesses above 220 mg/L $CaCO_3$.

Table 1B: Water quality criteria for the protection of aquatic life for waters outside of the Great Lakes system.

Metal[1]	Current Aquatic Life Criteria (µg/L)		Proposed Aquatic Life Criteria (µg/L)		Comments
	Acute	Chronic	Acute	Chronic	
Lead (Dissolved)	$(e^{(1.273\ [\ln(\text{hardness})]-1.460)})$ X 1.46203-[(ln hardness)(0.145712)]	$(e^{(1.273\ [\ln(\text{hardness})]-4.705)})$ X 1.46203-[(ln hardness)(0.145712)]	$(e^{(1.273\ [\ln(\text{hardness})]-1.055)})$ X 1.46203-[(ln hardness)(0.145712)]	$(e^{(1.273\ [\ln(\text{hardness})]-3.557)})$ X 1.46203-[(ln hardness)(0.145712)]	Acute criterion same as First Notice. Chronic criterion revised from First Notice, and is less stringent. Both proposed criteria are less stringent than current criteria.
Mercury (Total Recoverable)	2.4	0.012	2.4	0.012	Current criteria will be retained.
Mercury (Dissolved)	No current criterion	No current criterion	No proposed criterion	No proposed criterion	Removed from proposed criteria in First Notice since current criteria for total mercury will be retained
Nickel (Dissolved)	$(e^{(0.8460\ [\ln(\text{hardness})]+3.3612)})$ X 0.998	$(e^{(0.8460\ [\ln(\text{hardness})]+1.1645)})$ X 0.997	$(e^{(0.846\ [\ln(\text{hardness})]+2.255)})$ X 0.998	$(e^{(0.846\ [\ln(\text{hardness})]+0.0584)})$ X 0.997	No change, same as First Notice. Proposed criteria are more stringent than current criteria.
Selenium (Dissolved)	130 (Total Recoverable)	35 (Total Recoverable)	No proposed national criterion	See Table 1C	Proposed removal of acute criterion in First Notice unchanged. Proposed chronic criterion in First Notice replaced in Second Notice with USEPA 2016 NRWQC, a multi-media criterion that includes fish tissue and water column elements.
Silver (Dissolved)	$(e^{(1.72\ [\ln(\text{hardness})]-6.52)}/2)$ X 0.85	No current criterion	$(e^{(1.72\ [\ln(\text{hardness})]-6.59)})$ X 0.85	No proposed national criterion	No change, same as First Notice. Proposed acute criterion is less stringent than current acute criterion.
Zinc (Dissolved)	$(e^{(0.8473\ [\ln(\text{hardness})]+0.8604)})$ X 0.978	$(e^{(0.8473\ [\ln(\text{hardness})]+0.7614)})$ X 0.986	$(e^{(0.8473\ [\ln(\text{hardness})]+0.884)})$ X 0.978	$(e^{(0.8473\ [\ln(\text{hardness})]+0.884)})$ X 0.986	No change, same as First Notice. Proposed criteria are less stringent than current criteria.

[1] For those metals expressed in terms of dissolved metal in the water column, the water quality criterion is calculated by multiplying the aquatic life criterion, which is expressed in terms of total recoverable metal, by a conversion factor. The equation for this calculation is shown on the table.

With the exception of aluminum, the equations can be used to calculate numeric criteria at any water hardness up to 400 mg/L $CaCO_3$.

The criteria at a water hardness of 400 mg/L $CaCO_3$ are used for water hardnesses above 400 mg/L $CaCO_3$. For aluminum, the water hardness is capped at 220 mg/L. The criteria at a water hardness of 220 mg/L $CaCO_3$ are used for water hardnesses above 220 mg/L $CaCO_3$

Table 1C: Proposed selenium water quality criteria for the protection of aquatic life for waters outside of the Great Lakes system.

Chronic Aquatic Criterion (CAC)					
Fish Tissue (mg/kg dry weight)			Water Column (µg/L)		
Egg or ovary	Whole Body	Muscle (skinless, boneless filet)	Lentic Aquatic Systems	Lotic Aquatic Systems	Short Term, Intermittent Lentic and Lotic Aquatic Systems
15.1[1,2]	8.5[2,3]	11.3[2,3]	1.5 (30 day)[4,5]	3.1 (30 day)[5,6]	Intermittent exposure equation[4,5,6,7]

[1]Egg or ovary supersedes any whole-body, muscle or water column element when fish egg or ovary concentrations are measured. Duration: Instantaneous measurement.

[2]Frequency: Not to be exceeded.

[3]Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Duration: Instantaneous measurement.

[4]Water column values are based on dissolved total selenium in water (includes all oxidation states, i.e., selenite, selenate, organic selenium and any other forms) and are derived from fish tissue values via bioaccumulation modeling.

[5]Frequency: Not to be exceeded more than once in three years on average.

[6]Intermittent Exposure Equation =

$$\frac{WQC_{30\text{-day}} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$$

where $WQC_{30\text{-day}}$ is the water column monthly element for either lentic or lotic waters; C_{bkgrnd} is the average background selenium concentration; f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur; with f_{int} assigned a value ≥ 0.033 (corresponding to one day).

[7]Duration: Number of days per month with an elevated concentration

Table 2A: Water quality criteria for the protection of aquatic life for waters within the Great Lakes system.

Metal[1]	Current Aquatic Life Criteria (µg/L)		Proposed Aquatic Life Criteria (µg/L)		Comments
	Acute	Chronic	Acute	Chronic	
Aluminum (Total Recoverable)	No current criterion	No current criterion	$e^{(1.3695\ [\ln(\text{hardness})]+1.8308)}$	$e^{(1.3695\ [\ln(\text{hardness})]+0.9161)}$	USEPA's current acute and chronic NRWQC are 750 and 87 µg/L, respectively. The proposed equations are based on New Mexico's current criteria which are also applicable to Indiana's waters. These are hardness-based criteria, and the equations only apply within a pH range of 6.5 and 9.0.
Arsenic (Dissolved)	339.8 X 1.000	147.9 X 1.000	340 X 1.000	150 X 1.000	Added to Second Notice table. Changed from Arsenic (III) to Total Arsenic and rounded to 2 significant digits.
Cadmium (Dissolved)	$(e^{(1.128\ [\ln(\text{hardness})]-3.6867)})$ X 1.136672-[(ln hardness)(0.041838)]	$(e^{(0.7852\ [\ln(\text{hardness})]-2.715)})$ X 1.101672-[(ln hardness)(0.041838)]	$(e^{(0.9789\ [\ln(\text{hardness})]-3.866)})$ X 1.136672-[(ln hardness)(0.041838)]	$(e^{(0.7977\ [\ln(\text{hardness})]-3.909)})$ X 1.101672-[(ln hardness)(0.041838)]	Proposed criteria in First Notice replaced with USEPA 2016 NRWQC. Proposed criteria are more stringent than current criteria.
Chromium (VI) (Dissolved)	16.02 X 0.982	10.98 X 0.962	16 X 0.982	11 X 0.962	Added to Second Notice table. Rounded to 2 significant digits.
Lead (Dissolved)	No current criterion	No current criterion	$(e^{(1.273\ [\ln(\text{hardness})]-1.055)})$ X 1.46203-[(ln hardness)(0.145712)]	$(e^{(1.273\ [\ln(\text{hardness})]-3.557)})$ X 1.46203-[(ln hardness)(0.145712)]	Chronic criterion revised from First Notice, and is less stringent. Acute criterion same as First Notice.
Selenium (Dissolved)	No current criterion	5 X 0.922	No proposed national criterion	See Table 2B	Proposed change to chronic criteria added to Second Notice. Propose to replace existing chronic criterion with USEPA 2016 NRWQC, a multi-media criterion that includes fish tissue and water column elements.

[1] For those metals expressed in terms of dissolved metal in the water column, the water quality criterion is calculated by multiplying the aquatic life criterion, which is expressed in terms of total recoverable metal, by a conversion factor. The equation for this calculation is shown on the table.
With the exception of aluminum, the equations can be used to calculate numeric criteria at any water hardness up to 400 mg/L $CaCO_3$.
The criteria at a water hardness of 400 mg/L $CaCO_3$ are used for water hardnesses above 400 mg/L $CaCO_3$. For aluminum, the water hardness is capped at 220 mg/L. The criteria at a water hardness of 220 mg/L $CaCO_3$ are used for water hardnesses above 220 mg/L $CaCO_3$

Table 2B: Proposed selenium water quality criteria for the protection of aquatic life for waters within the Great Lakes system.

Criterion Continuous Concentration (CCC)					
Fish Tissue (mg/kg dry weight)			Water Column (µg/L)		
Egg or ovary	Whole Body	Muscle (skinless, boneless filet)	Lentic Aquatic Systems	Lotic Aquatic Systems	Short Term, Intermittent Lentic and Lotic Aquatic Systems
15.1[1,2]	8.5[2,3]	11.3[2,3]	1.5 (30 day)[4,5]	3.1 (30 day)[4,5]	Intermittent exposure equation[4,5,6,7]

[1]Egg or ovary supersedes any whole-body, muscle or water column element when fish egg or ovary concentrations are measured. Duration: Instantaneous measurement.

[2]Frequency: Not to be exceeded.

[3]Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Duration: Instantaneous measurement.

[4]Water column values are based on dissolved total selenium in water (includes all oxidation states, i.e., selenite, selenate, organic selenium and any other forms) and are derived from fish tissue values via bioaccumulation modeling.

[5]Frequency: Not to be exceeded more than once in three years on average.

[6]Intermittent Exposure Equation =

$$\frac{WQC_{30\text{-day}} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$$

where $WQC_{30\text{-day}}$ is the water column monthly element for either lentic or lotic waters; C_{bkgrnd} is the average background selenium concentration; f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur; with f_{int} assigned a value ≥ 0.033 (corresponding to one day).

[7]Duration: Number of days per month with an elevated concentration.

Table 3A: Water quality criteria for the protection of human health for waters outside of the Great Lakes system.

Metal	Current Human Health Criteria for the Consumption of Water + Organism (µg/L)	Current Human Health Criteria for the Consumption of Organism Only (µg/L)	Proposed Human Health Criteria for the Consumption of Water + Organism (µg/L)	Proposed Human Health Criteria for the Consumption of Organism Only (µg/L)	Comments
Antimony	146	45,000	5.6	640	Proposed criteria are current NRWQC. Proposed criteria are more stringent than current criteria.
Arsenic (III)	0.022	0.175	No proposed criterion	No proposed criterion	Criteria to be removed from 327 IAC 2-1-6 (Table 6-1); national criteria are under revision.
Beryllium	0.068	1.17	No proposed national criterion	No proposed national criterion	Substance to be removed from 327 IAC 2-1-6 (Table 6-1)
Cadmium	10	No current criterion	No proposed national criterion	No proposed national criterion	Criterion to be removed from 327 IAC 2-1-6 (Table 6-1)
Chromium (III)	170,000	3,433,000	No proposed national criterion	No proposed national criterion	Criteria to be removed from 327 IAC 2-1-6 (Table 6-1)
Chromium (VI)	50	No current criterion	No proposed national criterion	No proposed national criterion	Criterion to be removed from 327 IAC 2-1-6 (Table 6-1)
Copper	No current criterion	No current criterion	1,300	No proposed national criterion	Proposed criterion is the current NRWQC
Lead	50	No current criterion	No proposed national criterion	No proposed national criterion	Criterion to be removed from 327 IAC 2-1-6 (Table 6-1)
Manganese	No current criterion	No current criterion	No proposed criterion	No proposed criterion	To be removed from First Notice table since proposed criteria in First Notice are not based on human health effects.

Table 3B: Water quality criteria for the protection of human health for waters outside of the Great Lakes system.

Metal	Current Human Health Criteria for the Consumption of Water + Organism (µg/L)	Current Human Health Criteria for the Consumption of Organism Only (µg/L)	Proposed Human Health Criteria for the Consumption of Water + Organism (µg/L)	Proposed Human Health Criteria for the Consumption of Organism Only (µg/L)	Comments
Mercury	0.14	0.15	0.14	0.15	Current criteria to be retained.
Methylmercury	No current criterion	No current criterion	No proposed criterion	No proposed criterion	Removed from First Notice table due to being addressed in a separate rulemaking
Nickel	13.4	100	610	4,600	Proposed criteria are current NRWQC. Proposed criteria are less stringent than current criteria.
Selenium	10	No current criterion	170	4,200	Proposed criteria are current NRWQC.
Silver	50	No current criterion	No proposed national criterion	No proposed national criterion	Criterion to be removed from 327 IAC 2-1-6 (Table 6-1)
Thallium	13	48	13	48	Current criteria to be retained. Criteria proposed in First Notice will be deleted since EPA has removed RfD value from IRIS assessment.
Zinc	No current criterion	No current criterion	7,400	26,000	Proposed criteria are current NRWQC