3745-1-40 **Methodologies for development of aquatic life criteria and values.**

All pollutants or combinations of pollutants, for which aquatic life criteria have not been adopted in rule 3745-1-35 of the Administrative Code, shall not exceed the water quality criteria or values derived using the procedures contained in this rule.

(A) Tier I acute aquatic criterion (AAC) and tier II acute aquatic value (AAV). This criterion and value apply outside the mixing zone to all aquatic life habitat use designations. This criterion and value shall be expressed as the quantity of chemical per liter of water (e.g., mg/l or ug/l). Paragraphs (A)(1) to (A)(3) of this rule shall be used to calculate the tier I AAC when acute toxicity data are available for species in at least eight families. Paragraph (A)(4) of this rule shall be used to calculate the tier II AAV when there are not enough toxicity data to use the procedures in paragraphs (A)(1) to (A)(3) of this rule but there is at least one EC_{50} or LC_{50} value for a species in one of the following three genera of the family Daphnidae: Ceriodaphnia sp., Daphnia sp., or Simocephalus sp.

(1) The procedures in paragraphs (A)(1) to (A)(3) of this rule shall be used to calculate the tier I AAC when LC_{50} or EC_{50} data for at least one species of freshwater animal in at least the eight different families identified as follows:

(a) The family Salmonidae in the class Osteichthyes.

(b) One other family (preferably a commercially or recreationally important warmwater species) in the class Osteichthyes (e.g., bluegill, channel catfish).

(c) A third family in the phylum Chordata (e.g., fish, amphibian).

(d) A planktonic crustacean (e.g., a cladoceran, copepod).

(e) A benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish).

(f) An insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge).

(g) A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca).

(h) A family in any order of insect or any phylum not already represented.

(2) When data are not available to show that acute toxicity to two or more species is similarly related to a water quality characteristic (e.g., hardness, pH or temperature), the tier I AAC shall be calculated using the procedures in

paragraphs (A)(2)(a) to (A)(2)(i) of this rule.

(a) For each species for which at least one acute value is available, the species mean acute value (SMAV) shall be calculated as the geometric mean of the results of all acceptable flow-through acute toxicity tests in which the concentrations of test material were measured with the most sensitive tested life stage of the species. For a species for which no such result is available, the SMAV shall be calculated as the geometric mean of all acceptable acute toxicity tests with the most sensitive tested life stage, i.e., results of flow-through tests in which the concentrations were not measured and results of static and renewal tests based on initial concentrations (nominal concentrations are acceptable for most test materials if measured concentrations are not available) of test material.

(b) For each genus for which one or more SMAVs are available, the genus mean acute value (GMAV) shall be calculated as the geometric mean of the SMAVs available for the genus.

(c) The GMAVs shall be ordered from high to low.

(d) Ranks (R) shall be assigned to the GMAVs from "one" for the lowest to "N" for the highest. If two or more GMAVs are identical, successive ranks are arbitrarily assigned.

(e) The cumulative probability (P), shall be calculated for each GMAV as R / (N + 1).

(f) The four GMAVs shall be selected which have cumulative probabilities closest to 0.05. If there are fewer than fifty-nine GMAVs, these will always be the four lowest GMAVs.

(g) Using the four selected GMAVs and Ps, the final acute value (FAV) shall be calculated as follows:

$$S^2 = \frac{\Sigma((\ln GMAV)^2) - \frac{(\Sigma(\ln GMAV))^2}{4}}{\Sigma(P) - \frac{(\Sigma(\sqrt{P}))^2}{4}}$$

$$L = \frac{\Sigma(\ln GMAV) - S(\Sigma(\sqrt{P}))}{4}$$

$$A = S(\sqrt{0.05}) + L$$

$$FAV = e^A$$

(h) If, for a commercially, recreationally or ecologically important species, the geometric mean of the acute values from flow-through tests in which the concentrations of test material were measured is lower than the calculated FAV, then that geometric mean shall be used as the FAV instead of the calculated FAV.

(i) The AAC shall be calculated by dividing the FAV by two.

(3) When enough data are available to show that acute toxicity to two or more species is similarly related to a water quality characteristic (e.g., hardness, pH or temperature), the tier I FAV shall be calculated using the procedures in paragraphs (A)(3)(a) to (A)(3)(l) of this rule or using an analysis of covariance. The two methods are equivalent and produce identical results. If two or more factors affect toxicity, multiple regression analysis shall be used.

(a) For each species for which comparable acute toxicity values are available at two or more different values of the water quality characteristic, a least squares regression of the acute toxicity values on the corresponding values of the water quality characteristic shall be performed to obtain the slope and its ninety-five per cent confidence limits for each species. Because the best documented relationship is that between hardness and acute toxicity of metals and a log-log relationship fits these data, geometric means and natural logarithms of both toxicity and water quality are used in the rest of this method. For relationships based on other water quality characteristics, such as pH or temperature, no transformation or a different transformation might fit the data better, and appropriate changes shall be made as necessary throughout this

method.

(b) Data for each species shall be evaluated as to whether or not they are relevant, taking into account the range and number of the tested values of the water quality characteristic and the degree of agreement within and between species. If useful slopes are not available for at least one fish and one invertebrate, or if the available slopes are too dissimilar, or if too few data are available to adequately define the relationship between acute toxicity and the water quality characteristic, the AAC shall be calculated using the procedures in paragraph (A)(2) of this rule, using the results of tests conducted under conditions and in waters similar to those commonly used for toxicity tests with the species.

(c) For each species, the geometric mean of the available acute values shall be calculated and then each of the acute values for a species shall be divided by the mean for the species. This calculation normalizes the acute values so that the geometric mean of the normalized values for each species individually and for any combination of species is 1.0.

(d) The values of the water quality characteristic shall be similarly normalized for each species individually using the procedure in paragraph (A)(3)(c) of this rule.

(e) Individually for each species a least squares regression of the normalized acute values on the water quality characteristic shall be performed. The resulting slopes and ninety-five per cent confidence limits will be identical to those obtained in paragraph (A)(3)(a) of this rule. If, however, the data are actually plotted, the line of best fit for each individual species will go through the point 1, 1 in the center of the graph.

(f) All the normalized data shall be treated as if they were for the same species and a least squares regression of all the normalized acute values on the corresponding normalized values of the water quality characteristic is performed to obtain the pooled acute slope, V, and its ninety-five per cent confidence limits. If all of the normalized data are actually plotted, the line of best fit will go through the point 1, 1 in the center of the graph.

(g) For each species the geometric mean, W, of the acute toxicity values and the geometric mean, X, of the values of the water quality characteristic shall be calculated. (These were calculated in paragraphs (A)(3)(c) and (A)(3)(d) of this rule.)

(h) For each species the natural logarithm (ln), Y, of the SMAV at a selected value, Z, of the water quality characteristic shall be calculated using the

equation:

$Y = \ln W - V(\ln X - \ln Z)$.

(i) For each species the SMAV at Z shall be calculated using the equation:

$SMAV = e^{Y}$.

(j) The FAV shall be obtained by using the procedures described in paragraphs (A)(2)(b) to (A)(2)(g) of this rule.

(k) If, for a commercially or recreationally important species the geometric mean of the acute values at Z from flow-through tests in which the concentrations of the test material were measured is lower than the FAV at Z, then the geometric mean shall be used as the FAV instead of the FAV.

(l) The final acute equation shall be written as:

$FAV = e^{(V[\ln(\text{water quality characteristic})] + A - V[\ln Z])}$,

Where:

V = pooled acute slope, and A = ln (FAV at Z). Because V, A, and Z are known, the FAV can be calculated for any selected value of the water quality characteristic.

(m) For any value of Z, the AAC shall be calculated by dividing the FAV by two.

(4) Tier II values.

(a) If the required data to derive the tier I AAC in paragraphs (A)(1) to (A)(3) of this rule are not present in the acute toxicity data base and at least one EC_{50} or LC_{50} value is available for a species in one of the following three genera of the family Daphnidae - Ceriodaphnia sp., Daphnia sp., or Simocephalus sp., a tier II secondary acute value (SAV) shall be calculated by dividing the lowest GMAV in the data base by the secondary acute factor (SAF) (see table 40-1 of this rule) corresponding to the number of satisfied minimum data requirements listed in the tier I methodology (see paragraph (A)(1) of this rule).

(b) The tier II AAV equals the SAV divided by two.

(c) If appropriate, the AAV shall be made a function of a water quality characteristic in a manner similar to that described in paragraph (A)(3) of this rule.

(B) Tier I chronic aquatic criterion (CAC) and tier II chronic aquatic value (CAV). This criterion and value apply outside the mixing zone to all aquatic life habitat use designations except the limited resource water use designation. This criterion and value shall be expressed as the quantity of chemical per liter of water (e.g., mg/l or ug/l). Paragraphs (B)(1) and (B)(2) of this rule are used to calculate the tier I CAC. Paragraphs (B)(3) and (B)(4) of this rule shall be used to calculate the tier II CAV when there are not enough toxicity data to use the method in paragraphs (B)(1) and (B)(2) of this rule.

(1) If chronic values are available for species in eight families as described in paragraph (A)(1) of this rule, a species mean chronic value (SMCV) shall be calculated for each species for which at least one chronic value is available by calculating the geometric mean of the results of all acceptable life-cycle and partial life-cycle toxicity tests with the species; for a species of fish for which no such result is available, the SMCV shall be the geometric mean of all acceptable early life-stage tests. Appropriate genus mean chronic values (GMCVs) shall also be calculated. A GMCV shall be the geometric mean of the SMCVs for the genus. The CAC shall be obtained using the procedure contained in paragraphs (A)(1) to (A)(3) of this rule, substituting CAC for FAV, SMCV for SMAV and GMCV for GMAV.

(2) If chronic data for a chemical are not available for at least eight freshwater species meeting the requirements in paragraph (A)(1) of this rule, the CAC shall be calculated by dividing the FAV by a final acute-chronic ratio (FACR).

(a) Acute-chronic ratio (ACRs) are required for at least one species of aquatic animal in at least three different families provided that of the three species conform to the following:

(i) At least one is a fish.

(ii) At least one is an invertebrate.

(iii) At least one species is an acutely sensitive freshwater species (the other two may be saltwater species).

(b) For each chronic value for which at least one corresponding appropriate acute value is available, an ACR shall be calculated using the chronic value for the denominator and using the geometric mean of the results of all acceptable flow-through (except static is acceptable for daphnids and midges) acute tests in the same dilution water in which the concentrations are measured for the numerator. For fish, the acute test shall be conducted with juveniles. The acute test should be part of the same study as the chronic test. If acute tests were not conducted as part of the same study, but were conducted as part of a different study in the

same laboratory and dilution water, then they may be used. If no such acute tests are available, results of acute tests conducted in the same dilution water in a different laboratory may be used. If no such acute tests are available, an ACR shall not be calculated.

(c) For each species, the species mean ACR shall be calculated as the geometric mean of all ACRs available for that species. If the minimum ACR data requirements (as described in paragraph (B)(2)(a) of this rule) are not met with freshwater data alone, saltwater data may be used along with the freshwater data.

(d) For some materials, the ACR seems to be the same for all species, but for other materials the ratio seems to increase or decrease as the SMAV increases. Thus the FACR shall be obtained in the following ways:

(i) If the species mean ACR seems to increase or decrease as the SMAVs increase, the FACR shall be calculated as the geometric mean of the ACRs for species whose SMAVs are close to the FAV.

(ii) If no major trend is apparent and the ACRs for all species are within a factor of ten, the FACR shall be calculated as the geometric mean of all of the species mean ACRs.

(iii) If the most appropriate species mean ACRs are less than 2.0, the FACR shall be assumed to be 2.0.

(e) The FCV shall be calculated by dividing the FAV by the FACR.

(f) If the SMCV of a commercially or recreationally important species is lower than the calculated CAC, then that SMCV shall be used as the CAC instead of the calculated CAC.

(3) Secondary acute-chronic ratio.

If fewer than three acceptable experimentally determined ACRs are available for the chemcial, the secondary acute-chronic ratio (SACR) shall be determined using enough assumed ACRs of eighteen so that the total number of ACRs equals three. Calculate the SACR as the geometric mean of the three ACRs. If no experimentally determined ACRs are available, the SACR shall be eighteen.

(4) Tier II chronic aquatic value.

(a) The CAV shall be calculated using one of the following equations:

(i) CAV = FAV / SACR (Use FAV from paragraph (A) of this rule and

use SACR from paragraph (B)(3) of this rule).

(ii) CAV = SAV / FACR (Use SAV from paragraph (A)(4) of this rule and use FACR from paragraph (B)(2) of this rule).

(iii) CAV = SAV/ SACR (Use SAV from paragraph (A)(4) of this rule and use SACR from paragraph (B)(3) of this rule).

(b) If appropriate, the CAV shall be made a function of a water quality characteristic in a manner similar to that described in paragraph (A)(3) of this rule.

(c) If the SMCV of a commercially or recreationally important species is lower than the calculated CAV, then that SMCV shall be used as the CAV instead of the calculated CAV.

(C) Final plant value (FPV). This value applies in place of the CAC or CAV if it is lower than the CAC or CAV. Results of at least one acceptable test with a freshwater algae or vascular plant is required. If plants are among the aquatic organisms most sensitive to the material, results of a test with a plant in another phylum (division) shall also be available.

(1) A plant value shall be the result of a ninety-six-hour test conducted with an alga or a chronic test conducted with an aquatic vascular plant. A test of the toxicity of a metal to a plant shall not be used if the medium contained an excessive amount of a complexing agent, such as EDTA, that might affect the toxicity of the metal. Concentrations of EDTA above two hundred micrograms per liter shall be considered excessive.

(2) The FPV shall be obtained by selecting the lowest result from a test with an important aquatic plant species in which the concentrations of test material are measured and the endpoint is biologically important.

(D) Application of criteria and values.

(1) The FAV and SAV shall be applied as maximum concentrations inside the mixing zone.

(2) The AAC and AAV shall be applied as maximum concentrations outside the mixing zone.

(3) The CAC, CAV, and FPV if available shall be applied as thirty-day average concentrations outside the mixing zone.

Table 40-1.

Secondary acute factors

Number of minimum data requirements satisfied	Secondary acute factor
1.....	21.9
2 and neither requirement includes the family Salmonidae.....	13.0
2 and one requirement includes the family Salmonidae.....	7.9
3.....	8.0
4.....	7.0
5.....	6.1
6.....	5.2
7.....	4.3

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