

## **APPENDIX C**

### **SAMPLE CALCULATION OF PERMIT LIMITS USING EPA'S STATISTICALLY-BASED METHODOLOGY AND SAMPLE PERMIT LANGUAGE**

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# SAMPLE CALCULATIONS OF PERMIT LIMITS USING EPA'S STATISTICALLY-BASED METHODOLOGY AND SAMPLE PERMIT LANGUAGE

The NPDES regulation (40 CFR Part 122.44(d)(1)) implementing section 301 (b)(1)(C) of the CWA requires that permits include limits for all pollutants or parameters that “*are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality.*” Once it has been established that a permit limit is needed, Federal regulations at 40 CFR Part 122.45(d) require that limits be expressed as maximum daily discharge limits (MDL) and average monthly discharge limits (AML) for all dischargers other than publicly owned treatment works (POTWs), and as average weekly and average monthly discharge limits for POTWs, unless impracticable. EPA does not believe that it is impracticable to express WET permit limits as MDLs and AMLs.

## C.1 Sample Calculations

To set MDLs and AMLs based on acute and chronic wasteload allocations (WLAs), use the following four steps.

1. Convert the acute wasteload allocation to chronic toxic units.
2. Calculate the long-term average wasteload that will satisfy the acute and chronic wasteload allocations.
3. Determine the lower (more limiting) of the two long-term averages.
4. Calculate the maximum daily and average monthly permit limits using the lower (more limiting) long-term average.

### *Step 1 - Determine the Wasteload Allocation*

The acute and chronic aquatic life criteria are converted to acute and chronic wasteload allocations (WLAa or WLAc) for the receiving waters based on the following mass balance equation:

$$Q_d C_d = Q_e C_e + Q_u C_u \quad \text{(Eq. 1)}$$

where

- $Q_d$  = downstream flow =  $Q_u + Q_e$
- $C_d$  = aquatic life criteria that cannot be exceeded downstream
- $Q_e$  = effluent flow
- $C_e$  = concentration of pollutant in effluent = WLAa or WLAc
- $Q_u$  = upstream flow
- $C_u$  = upstream background concentration of pollutant.

Rearranging Equation 1 to determine the effluent concentration ( $C_e$ ) or the wasteload allocation (WLA) results in the following:

$$C_e = WLA = \frac{Q_d C_d - Q_u C_u}{Q_e} \quad \text{(Eq. 2)}$$

When a mixing zone<sup>1</sup> is allowed, this equation becomes:

$$C_e = WLA = \left[ \frac{C_d(Q_u \times \%MZ) + C_d Q_e}{Q_e} \right] - \left[ \frac{Q_u C_u (\%MZ)}{Q_e} \right] \quad \text{(Eq. 2a)}$$

where %MZ is the mixing zone allowable by State standards. In this example, the State authorized a mixing zone of 50 percent of river volume for WET. The effluent limits were derived using the State's guidelines. Establishing a mixing zone, however, is a discretionary function of the State. If the State does not certify a mixing zone in the 401 certification process, the effluent limits must be recalculated without a mixing zone.

There is an additional step for WET. The WLAa needs to be converted from acute toxic units (TUa) to chronic toxic units (TUc). The acute WLA is converted into an equivalent chronic WLA by multiplying the acute WLA by an acute-to-chronic ratio (ACR). Optimally, this ratio is based on effluent data. A default value of 10, however, can be used based on the information presented in Chapter 1 and Appendix A of the TSD.

<b>WLAa,c = WLAa × ACR, where</b>
<b>ACR = acute-to-chronic ratio</b>

For this example, the following information applies:

	C <sub>d</sub>	Q <sub>e</sub>	Q <sub>u</sub>	%MZ	Q <sub>umix</sub> <sup>a</sup>	Q <sub>d</sub>	C <sub>u</sub>	CV <sup>b</sup>
Acute	0.3 TUa	15.5 cfs	109 cfs	50	54.5 cfs	70 cfs	0 TU <sub>a</sub>	0.6
Chronic	1.0 TUc	15.5 cfs	170 cfs	50	85 cfs	100.5 cfs	0 TU <sub>c</sub>	0.6

<sup>a</sup> Q<sub>umix</sub> is the upstream flow in the mixing zone (Q<sub>umix</sub> = Q<sub>u</sub> × %MZ)

<sup>b</sup> Only 7 valid data points were available, so a default coefficient of variation was used in the calculations.

$$WET\ WLAa = \left[ \frac{(0.3TUa) \times (109 \times 0.50) + (0.3 \times 15.5)}{15.5} \right] - \left[ \frac{109 \times 0 \times 0.25}{15.5} \right] = 1.35TUa$$

$$WET\ WLAa,c = 10 \times 1.35TUa = 13.5TUa,c$$

$$WET\ WLAc = \left[ \frac{1.0TUc \times (170 \times 0.50) + (1.0 \times 15.5)}{15.5} \right] - \left[ \frac{170 \times 0 \times 0.50}{15.5} \right] = 6.5TUc$$

### Step 2 - Determine the Long-Term Average (LTA)

The acute WLA is converted to a long-term average concentration (LTAa,c) using the following equation:

$$LTAa,c = WLAa,c \times e^{[0.5\sigma^2 - z\sigma]} \quad \text{(Eq. 3)}$$

where,

$$\sigma^2 = \ln(CV^2 + 1) = \ln(0.6^2 + 1) = 0.307; \sigma = 0.555$$

$$z = 2.326 \text{ for } 99^{\text{th}} \text{ percentile probability basis}$$

$$CV = \text{coefficient of variation} = \text{standard deviation}/\text{mean} = 0.6$$

$$\text{Acute multiplier} = e^{(0.5 \times 0.307 - (2.326 \times 0.555))} = 0.321.$$

$$LTAa,c = 13.5TUa,c \times 0.321 = 4.33TUa,c$$

<sup>1</sup> A mixing zone is an allocated impact zone where water quality criteria can be exceeded if acutely toxic conditions are prevented. Only the State has the regulatory authority to grant the establishment of a mixing zone.

The chronic WLA is converted to a long-term average concentration (LTAc) using the following equation:

$$LTAc = WLAc \times e^{[0.5s^2 - zs]} \quad (\text{Eq. 4})$$

where,

$$\sigma^2 = \ln(CV^2/4 + 1) = \ln(0.6^2/4 + 1) = 0.086; \sigma = 0.294$$

$$z = 2.326 \text{ for } 99^{\text{th}} \text{ percentile probability basis}$$

$$CV = \text{coefficient of variation} = \text{standard deviation/mean} = 0.6$$

$$\text{Chronic multiplier} = e^{(0.5 \times 0.086 - 2.326 \times 0.294)} = 0.542.$$

$$LTAc = 6.5 TU_c \times 0.542 = 3.43 TU_c$$

### Step 3 - Determine the More Limiting Long-Term Average

To protect a waterbody from both acute and chronic effects, the more limiting of the calculated LTAA and LTAc is used to derive the effluent limits. The TSD recommends using the 95<sup>th</sup> percentile for the AML and the 99<sup>th</sup> percentile for the MDL. As shown above, the LTAc value was less than the LTAA value.

### Step 4 - Determine the Permit Limits

The MDL and the AML are calculated as follows.

$$MDL = LTAc \times e^{[zs - 0.5s^2]} \quad (\text{Eq. 5})$$

where,

$$\sigma^2 = \ln(CV^2 + 1) = 0.307; \sigma = 0.555$$

$$z = 2.326 \text{ for } 99^{\text{th}} \text{ percentile probability basis}$$

$$CV = \text{coefficient of variation} = 0.6$$

$$AML = LTAc \times e^{[zs - 0.5s^2]} \quad (\text{Eq. 6})$$

where,

$$\sigma^2 = \ln(CV^2/n + 1) = 0.086; \sigma = 0.294$$

$$z = 1.645 \text{ for } 95^{\text{th}} \text{ percentile probability basis}$$

$$CV = \text{coefficient of variation} = 0.6$$

$$n = \text{number of sampling events required per month for WET} = 1$$

$$n = 4 \text{ for calculations}^2$$

The following table lists the effluent limits for this example:

Parameter	CV	LTAc	$e^{[zs - 0.5s^2]}$ (for MDL)	$e^{[z\sigma - 0.5\sigma^2]}$ (for AML)	MDL	AML
WET	0.6	3.43	3.11	2.13	10.7 TU <sub>c</sub>	7.3 TU <sub>c</sub>

<sup>2</sup> When the sample frequency is monthly or less than monthly, the TSD recommends that “n” be set equal to 4.

## C.2 Sample Chronic Toxicity Permit Language

Sample chronic toxicity permit language is provided in the following paragraphs. Alternative wording, as appropriate for a specific permit, is provided in redline typeface for the regulatory authority to decide.

The permittee shall conduct **monthly/quarterly/semi-annual/annual** toxicity tests on **grab/24-hour composite** effluent samples. Samples shall be taken at the NPDES sampling location. In addition, a split of each sample collected must be analyzed for the chemical and physical parameters required in Part I.A below. When the timing of sample collection coincides with timing of the sampling required in Part I.A, analysis of the split sample will fulfill the requirements of Part I.A. as well.

### 1. Test Species and Methods

#### **NOTE: CHOOSE EITHER FRESHWATER OR MARINE LANGUAGE**

##### Freshwater

- a. The permittee shall conduct short-term tests with the cladoceran, water flea, *Ceriodaphnia dubia* (survival and reproduction test), the fathead minnow, *Pimephales promelas* (larval survival and growth test), and the green alga, *Selenastrum capricornutum* (growth test) for the first three suites of tests. After this screening period, monitoring shall be conducted using the most sensitive species.
- b. Every year, the permittee shall re-screen once with the three species listed above and continue to monitor with the most sensitive species. Re-screening shall be conducted at a different time of year from the previous year's re-screening. **Note to permit writers: If testing is annual or less than annual, omit this step.**
- c. The presence of chronic toxicity shall be estimated as specified in EPA's methods (USEPA 1994b).

##### Marine and Estuarine

- a. The permittee shall conduct tests as follows with a vertebrate, an invertebrate, and a plant for the first three suites of tests. After the screening period, monitoring shall be conducted using the most sensitive species.
- b. Every year, the permittee shall re-screen once with the three species listed above and continue to monitor with the most sensitive species. Re-screening shall be conducted at a different time of year from the previous year's re-screening. **Note to permit writers: If testing is annual or less, omit this step.**

##### **For West Coast only:**

- c. The presence of chronic toxicity shall be estimated as specified using West Coast marine organisms according to EPA's methods (USEPA 1995).

**or**

##### **For East Coast only:**

- c. The presence of chronic toxicity shall be estimated as specified using East Coast marine organisms according to EPA's methods (USEPA 1994c).

## 2. Toxicity Limits/Toxicity Monitoring Trigger

- a. Chronic toxicity measures a sublethal effect (e.g., reduced growth, reproduction) to experimental test organisms exposed to an effluent or ambient waters compared to that of the control organisms. **When a permit limit is appropriate, the chronic toxicity limitation is written based on State Water Quality Standards. If a permit limit is not appropriate, then this section should be called “Toxicity Monitoring Trigger.”**
- b. Results shall be reported in  $TU_c$ , where  $TU_c = 100/NOEC$  or  $100/IC_p$  or  $EC_p$  (in percent effluent). The no observed effect concentration (NOEC) is the highest concentration of toxicant to which organisms are exposed in a chronic test that causes no observable adverse effect on the test organisms (e.g., the highest concentration of toxicant to which the values for the observed responses are not statistically significantly different from the controls). The inhibition concentration, IC, is a point estimate of the toxicant concentration that causes a given percent reduction (p) in a non-quantal biological measurement (e.g., reproduction or growth) calculated from a continuous model (the EPA Interpolation Method). The effective concentration, EC, is a point estimate of the toxicant concentration that would cause a given percent reduction (p) in quantal biological measurement (e.g., larval development, survival) calculated from a continuous model (e.g., Probit).

## 3. Quality Assurance

- a. A series of at least five dilutions and a control will be tested. The series shall include the instream waste concentration (IWC) (**permit writer should insert the actual value of the IWC**), two dilutions above the IWC, and two dilutions below the IWC. The IWC is the concentration of effluent at the edge of the mixing zone. **If there is no mixing zone, then the dilution series would be the following concentrations: 12.5, 25, 50, 75, and 100 percent effluent.**
- b. If organisms are not cultured in-house, concurrent testing with a reference toxicant shall be conducted. Where organisms are cultured in-house, monthly reference toxicant testing is sufficient. Reference toxicant tests also shall be conducted using the same test conditions as the effluent toxicity tests (e.g., same test duration, etc).
- c. If either the reference toxicant test or effluent test does not meet all test acceptability criteria (TAC) as specified in the manual, then the permittee must re-sample and re-test **within 14 days or as soon as possible.**
- d. The reference toxicant and effluent tests must meet the upper and lower bounds on test sensitivity as determined by calculating the percent minimum significant difference (PMSD) for each test result. The test sensitivity bound is specified for each test method (see variability document EPA/833-R-00-003, Table 3-6). There are five possible outcomes based on the PMSD result:
  1. **Unqualified Pass**—The test’s PMSD is within bounds and there is no significant difference between the means for the control and the IWC treatment. The regulatory authority would conclude that there *is no toxicity at the IWC concentration.*
  2. **Unqualified Fail**—The test’s PMSD is larger than the lower bound (but not greater than the upper bound) in Table 3-6 and there is a significant difference between the means for the control and the IWC treatment. The regulatory authority would conclude that there *is toxicity at the IWC concentration.*
  3. **Lacks Test Sensitivity**—The test’s PMSD exceeds the upper bound in Table 3-6 and there is no significant difference between the means for the control and the IWC treatment. The test

is considered invalid. An effluent sample must be collected and another toxicity test must be conducted. The permittee must re-sample and retest within **fourteen (14) days or as soon as possible**.

4. **Lacks Test Sensitivity**—The test's PMSD exceeds the upper bound in Table 3-6 and there is a significant difference between the means for the control and the IWC treatment. The test is considered valid. The regulatory authority will conclude that the *is toxicity at the IWC concentration*.
5. **Very Small but Significant Difference**—The relative difference (see Section 6.4.2, below) between the means for the control and the IWC treatment is smaller than the lower bound in Table 3-6 and this difference is statistically significant. The test is acceptable. The NOEC is determined as described in Sections 6.4.2 and 6.4.3 (below).

- e. Control and dilution water should be **receiving water or laboratory water, as appropriate, as described in the manual**. If the dilution water used is different from the culture water, a second control using culture water shall be used.

#### 4. Preparing the Initial Investigation of the TRE Workplan

The permittee shall submit to EPA a copy of the permittee's initial investigation Toxicity Reduction Evaluation (TRE) workplan (1-2 pages) within 90 days of the effective date of this permit. This plan shall describe the steps the permittee intends to follow if toxicity is detected, and should include, at least the following items:

- a. A description of the investigation and evaluation techniques that would be used to identify potential causes and sources of toxicity, effluent variability, and treatment system efficiency.
- b. A description of the facility's methods of maximizing in-house treatment efficiency and good housekeeping practices.
- c. If a toxicity identification evaluation (TIE) is necessary, an indication of the person who would conduct the TIEs (i.e., an in-house expert or an outside contractor).

#### 5. Accelerated Testing

- a. If the initial investigation indicates the source of toxicity (for instance, a temporary plant upset), then only one additional test is necessary. If toxicity is detected in this test as specified in Section 2a, then Section 6 shall apply.
- b. **If chronic toxicity/the chronic toxicity monitoring requirements as defined in Section 2a are triggered**, then the permittee shall conduct six more tests, approximately every two weeks, over a twelve-week period. Testing shall commence within two weeks of receipt of the sample results of the exceedance of the WET monitoring trigger.
- c. If none of the six tests indicate toxicity as specified in Section 2a, then the permittee may return to the normal testing frequency.

#### 6. Toxicity Reduction Evaluation (TRE) and Toxicity Identification Evaluation (TIE)

- a. If chronic toxicity (defined as either the **toxicity permit limit or monitoring trigger** specified in Section 2a) is detected in any of the six additional tests, then, in accordance with the facility's initial investigation according to the TRE workplan, the permittee shall initiate a TRE within

**fifteen (15)** days of the exceedance to reduce the cause(s) of toxicity. At a minimum, the permittee shall use EPA manuals **EPA/600/2-88/070 (industrial)** or **EPA/833B-99/002 (municipal)** as guidance. The permittee will expeditiously develop a more detailed TRE workplan, which includes:

- (1) Further actions to investigate and identify the cause of toxicity
- (2) Actions the permittee will take to mitigate the impact of the discharge and prevent the recurrence of toxicity
- (3) A schedule for these actions

- b. The permittee may initiate a TIE as part of the TRE process to identify the cause(s) of toxicity. The permittee shall use the EPA acute and chronic manuals, **EPA/600/6-91/005F (Phase I)/EPA/600/R-96-054 (for marine)**, EPA/600/R-92/080 (Phase II), and EPA-600/R-92/081 (Phase III) as guidance.

## 7. Reporting

- a. The permittee shall submit the results of the toxicity tests, including any accelerated testing conducted during the month, in TUs with the discharge monitoring reports (DMR) for the month in which the test is conducted. If an initial investigation indicates the source of toxicity and accelerated testing is unnecessary, pursuant to Section 5, then those results also shall be submitted with the DMR for the quarter in which the investigation occurred.
- b. The full report shall be submitted by the end of the month in which the DMR is submitted.
- c. The full report shall consist of (1) the results; (2) the dates of sample collection and initiation of each toxicity test; (3) the monthly average **limit or trigger** and daily maximum **limit or trigger** as described in Section 2a.
- d. Test results for chronic tests also shall be reported according to the chronic manual chapter on Report Preparation and shall be attached to the DMR.
- e. The permittee shall notify EPA in writing 15 days after the receipt of the results of a monitoring **limit or trigger**. The notification will describe actions the permittee has taken or will take to investigate and correct the cause(s) of toxicity. It may also include a status report on any actions required by the permit, with a schedule for actions not yet completed. If no actions have been taken, the reasons shall be given.

## 8. Reopener

- a. This permit may be modified in accordance with the requirements set forth at 40 CFR Parts 122 and 124 to include appropriate conditions or limits to address demonstrated effluent toxicity based on newly available information.

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