<table>
<tr><td rowspan="2">Permit Guidance
13
Draft</td><td colspan="2">Effluent Toxicity Evaluations and Limits</td></tr>
<tr><td>Rule reference: OAC 3745-1-04(D), OAC 3745-1-44,
OAC 3745-2-09 and OAC 3745-33-07(B)</td><td>Revision 0
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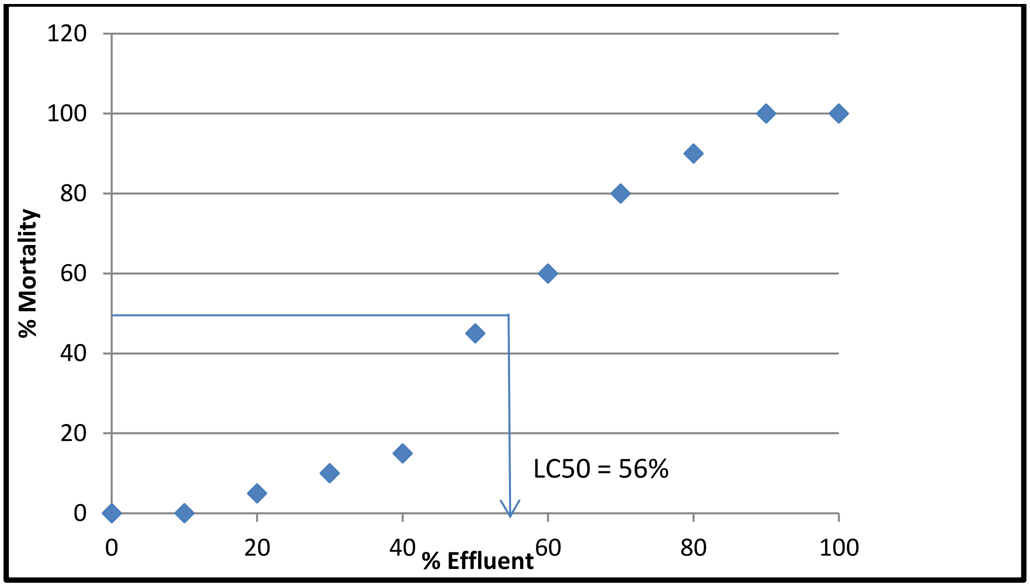
Introduction -

This guidance document discusses how to assess effluent toxicity data, when limits are required under Ohio's rules, and when toxicity reduction is required under OAC 3745-33-07(B). The guidance is intended to be used by DSW staff both for making permit decisions and enforcement decisions related to effluent toxicity.

Whole effluent toxicity (WET) is a direct measure of the toxicity of an effluent, using the survival, growth or reproduction of biological organisms as the test endpoint. WET can be directly limited in NPDES permits by establishing limits on toxic units (TUs), or by establishing an allowable toxic effect (e.g. 50% acute effect) in the pure effluent. We use WET as a tool because it can measure the effluent's overall toxic effect, measuring the effect of mixtures of toxic agents, the effect of chemicals for which we can't calculate water quality standards, or the effect of pollutants that can't be monitored (See rules above and the Technical Support Document for Water Quality-based Toxics Control, U.S. EPA Office of Water, March 1991 [Federal TSD].

There are two general types of toxicity tests - acute and chronic. Acute tests measure survival and mortality over a short time period (48- or 96-hours). Chronic tests measure survival and mortality, as well as effects on growth and reproduction over a longer period of the organism's life. **Note that the major difference between acute and chronic effects is the exposure time, not the severity of the effect**.

Acute toxicity tests are conducted to estimate the median lethal concentration (LC50) of an effluent or a particular chemical in water. The LC50 is the concentration estimated to produce mortality in 50% of a test population over a specific period of time, usually 24-96 hours. A graphical representation of a typical dose-response curve and estimation of the LC50 is illustrated below.



Chronic toxicity tests involve longer exposure periods. A chronic toxicity test can last from a week to over a year. Whole effluent chronic toxicity tests are used to study the effects of a continuous, long-term exposure to aquatic organisms. Toxicity testing under Ohio's WET program requires the following (from 40 CFR 136 – U.S. EPA Approved Test Methods):

	Acute		**Chronic**	
Organism	*Ceriodaphnia dubia*	Fathead minnow	*Ceriodaphnia dubia*	Fathead[a] minnow
Test Duration	2 days	4 days	7 days	7 days
Endpoint	Mortality	Mortality	Reproduction and Mortality	Growth and Mortality

[a] - Technically, this test is a short-term or subchronic toxicity test commonly used to estimate the chronic toxicity of effluents, based on the most sensitive stage of the organism's life.

Fathead minnows and the water flea *Ceriodaphnia dubia* are the standard test organisms used and required by Ohio EPA (again, from 40 CFR 136). Dischargers can ask Ohio EPA to allow data for alternative organisms; however, the sensitivity of the organism to the toxic agent cannot be the primary factor in the request [40 CFR 122.44(d)(1)(ii) and 40 CFR 122.44(i)(1)(iv)]. Alternative organism requests should be related to more complete life-cycle testing (e.g. using a 21-day *Daphnia Magna* test in place of the 7-day *C. dubia* test) or to the stream use/resource being protected (e.g., a Modified Warmwater Habitat vs. a Warmwater Habitat stream).

Ohio WQS for WET/ Toxic Units -

The Ohio Water Quality Standards list a narrative criterion for WET [OAC 3745-1-04(D)]. This is the 'no toxics in toxic amounts' language for ambient waters and 'no rapid lethality' language for mixing zones. These WQS are translated numerically according to the table below [from OAC 3745-2-09(A)].

Stream Use ->	**WWH, MWH, CWH, EWH, SSH**	**Undesignated Waters**	**Limited Resource Waters**
Ohio River Basin	0.3 TUa, 1.0 TUc	0.3 TUa, 1.0 TUa	1.0 TUa
Lake Erie Basin	0.3 TUa, 1.0 TUc	0.3 TUa, 1.0 TUc	0.3 TUa

The 1.0 TUc value is a direct measure of a "no effect level" of toxicity. As an ambient standard, a "no effect level" is considered the best approximation of 'no toxics in toxic amounts'. The 0.3 TUa value was developed by USEPA to be an approximation of a "no effect concentration" for acute toxicity. USEPA studied the ratio of available LC1 to LC50 data and found that a factor of 0.3 covered 91% of these ratios (ratios of "no effect level" to a toxic effect) (Federal TSD p.35).

Toxicity Units are used to translate toxicity measurements into units that can be used for permit limitations. These are used to relate an increasing scale of numbers to increasing levels of toxicity. TUs are defined as follows:

$$TU_a = \text{Acute Toxic Units} = \frac{100}{LC50}$$

$$TU_c = \text{Chronic Toxic Units} = \frac{100}{IC25}$$, except that for *Ceriodaphnia* tests

$$TU_c = \text{Chronic Toxic Units} = \frac{100}{\text{Geometric mean of NOEC and LOEC}}$$

when this measurement yields a higher TUc value than using 100/IC25 (see discussion below).

Where (from OAC 3745-2-02):

LC50 = the median lethal concentration; the percent by volume effluent concentration that kills 50% of exposed organisms during a specified exposure period.

IC_{25} = the inhibition concentration 25; the toxicant concentration that would cause a 25% reduction in a non-quantal (all-or-none) biological measurement (such as reproduction or growth) in the test population. For example, the IC_{25} is the concentration that would cause a 25% reduction in the number of young per female in a chronic daphnid test population or 25% reduction in growth in a chronic fathead minnow test population.

NOEC = the no observed effect concentration; the highest tested concentration (expressed as a percent by volume) of an effluent or a toxicant that causes no statistically significant observed effects on a test organism during a specified exposure period.

LOEC = the lowest observed effect concentration; the lowest measured concentration (expressed as a percent by volume) of an effluent or a toxicant that causes a statistically significant effect on a test organism during a specified exposure period.

For chronic tests the IC25 measure is used in most cases. Toxicologists developed this measure so that chronic tests would have a statistically-based measurement (similar to the LC50 for acute tests), and would have only one monitored endpoint (growth or reproduction). Survival/mortality that occurs early in the test (early enough to influence growth/reproduction data) is built into the procedure (because dead organisms can't reproduce). USEPA estimates that using the IC25 is not expected to result in any change in protectiveness in most cases (Federal TSD p.5). However, there are times when the NOEC/LOEC method gives a more restrictive TU value.

Mortality that occurs late in the 7-day test period for *Ceriodaphnia* does not register as toxicity in the IC25 measurement (because it does not influence reproduction). This may or may not be significant because if the organism reproduces before it dies, there may not be an impact from the discharge. Whether there is an impact depends on how frequently this type of toxicity occurs. The Agency believes that this is better answered in the reasonable potential process (considering all of the available data), rather than changing the definition of what is toxic. In these situations TUc values based on the NOEC/LOEC will be more restrictive than those based on IC25. The rule requires that TUc values based on NOEC/LOEC be used for *Ceriodaphnia* when they are more restrictive than those based on IC25 [OAC 3745-1-44].

Basic Toxicity Test Quality Assurance and Important Dose/Response Information -

Basic Test QA

All tests should be checked for validity using 40 CFR 136 and Ohio EPA's Biomonitoring Guidance. At least one test control water in an acute test must have $\leq$10% mortality for the test to be valid; at least one chronic test control must have $\leq$20% mortality for the test to be valid. If neither control passed QA, the test is invalid and must be repeated as soon as possible.

If the primary control test is valid, TUa and TUc values can be reported. If only the secondary control is valid, only pass/fail (aka screening) results can be reported. Rather than reporting a specific TU value, a facility would report acute tests as AA (below detection), values between 0.2 and 1.0 TUa as appropriate, or >1.0 TUa (if effluent mortality is greater than 50%). Chronic tests would be reported as either AA or >1.0 TUc.

Chronic tests also have QA criteria based on water fleas reproduction and fathead minnow growth. *Ceriodaphnia* controls must have at least 15 young/female for the test to be valid; an acceptable fathead minnow seven-day test requires a three-fold weight increase by the control organisms during the test or that the mean dry weight equal or exceed 0.25 mg.

If upstream water is shown to be toxic, or is suspected to be toxic based on chemical or biosurvey results, permits should require that laboratory water, rather than upstream water, be used for their primary controls.

Common Dose/Response Problems

There are a number of unusual dose/response patterns that require guidance. The most common pattern that we find is the issue of enriched control water. When streams have nutrient enrichment issues, toxicity test control waters can produce many more young *Ceriodaphnia* than the minimum required for test validity. Average young production of 30-35 young/ female is not uncommon in this situation. When primary control waters are this productive, even normal productivity (15-20 young/female) in an effluent can be significantly different than control. These results may not provide a valid indication of toxicity.

If upstream enrichment occurs, compare the effluent young production to the laboratory control (secondary control); if the effluent young production is not significantly different than the lab water control, there is no toxicity in the effluent, and results should be reported as AA. If the effluent productivity is significantly less than the laboratory control, the results should be read and reported as >1.0 TUc. Permittees should be encouraged to use lab water as the primary control if the upstream water is enriched.

Wasteload Allocation for WET -

Whole effluent toxicity is allocated to a discharge according to the provisions of OAC Rule 3745-2-09. WET is treated as a conservative (non-degrading) substance because the characteristics of the specific toxicant(s) in the effluent are usually unknown. Toxicity units are allocated based on meeting the values of 0.3 TUa and 1.0 TUc downstream of the discharge, and any available dilution. We use the same stream flows for acute and chronic toxicity that we would for acute and chronic chemical WQS (1Q10 for acute toxicity, 7Q10 for chronic), and the same mixing zone assumptions that would be used for chemical-specific WLAs. Allocations for acute toxicity are capped at 1.0 TUa unless the discharger demonstrates that an Area-of-Initial-Mixing (AIM) exists under OAC Rule 3745-2-08, or that one of the factors in OAC Rule 3745-33-07(B)(5)-(9) allows a higher TUa limit to be given (more explanation on these later).

A 1.0 TUa value is also the lowest TUa value that can be used as a permit limit [OAC 3745-33-07(B)(10)]. If there is evidence that effluent values between 0.3 TUa and 1.0 TUa cause or contribute to violations of WQS, then the Agency may require the permittee to investigate and remediate toxicity in this range [OAC 3745-33-07(B)(10)].

Where multiple discharges exist in the WLA segment, acute toxicity is allocated interactively between the discharges; that is the group of discharges is given one allocation, and each discharge is given a piece the allocation. In determining whether dischargers are interactive, consider the distance between discharge points, the effluent flows vs. stream flow, effluent toxicity data and whether the biological index measurements show signs of toxicity between the dischargers.

According to USEPA research, chronic toxicity is generally not interactive between discharges. Unless there is stream-specific information to suggest that the chronic toxicity from multiple discharges is having an additive effect, each upstream discharge should be considered dilution for a downstream discharge. [See Federal Technical Support Document for Water-Quality Based Toxics Control, March 1991, p. 24.]

"Reasonable Potential to Cause or Contribute to Excursions Above WQS" -

Overview

There are two separate reasonable potential procedures in Ohio – one for the Lake Erie watershed and one for the Ohio River watershed. Dischargers in the Ohio River watershed are assessed using OAC Rule 3745-33-07(B). However, in comparing this rule to the default procedures of the Great Lakes Initiative (GLI) Rule, U.S. EPA found that our state procedures were less restrictive than the GLI Rule. In response, U.S. EPA promulgated the GLI reasonable potential procedures for the Lake Erie watershed of Ohio in 2000 (40 CFR 132). This rule's requirements override the OAC 3745-33-07(B) procedures for determining whether toxicity limits are necessary in the Lake Erie Watershed.

The Ohio River watershed procedures rely on an assessment of environmental indicators, using a weight-of-evidence approach. The Lake Erie watershed procedures are more like the assessment of reasonable potential for chemical parameters, using just WLA and Projected Effluent Quality (PEQ) statistics.

Lake Erie Basin Procedures

This reasonable potential procedure works like reasonable potential for chemical parameters – you calculate PEQ values for acute and chronic toxicity and compare them to a WLA. PEQ values for toxicity are calculated using the PEQ spreadsheet. PEQs should be calculated using data for the most sensitive organism for each test date. For each test date, determine the most sensitive organism based on TU values, and use that TU value in the calculation (even if the data result in a mix of fathead minnow and water flea test results).

If you are missing chronic toxicity results, federal procedures require that we estimate effluent chronic TUs by multiplying the acute PEQ values by 10. If only acute toxicity data are available and all values are <1.0 TUa, the effluent is not considered to be toxic, and you should assess the toxicity conditions using the Ohio River Basin procedures to determine if the discharge should be Category 3 or 4.

WLAs for toxicity are calculated using the WLA spreadsheet. If the PEQ is greater than the WLA, the federal rule specifies that reasonable potential exists and limits for toxicity must generally be included in the permit. One exception is that if the PEQ is based on fewer than 6 samples, you may include an extended compliance schedule, with an interim period of more frequent monitoring to determine whether a toxicity problem exists. For acute toxicity, you may also use one of the factors in OAC Rule 3745-33-07(B)(5)-(9) that allows a higher TUa limit to be given (explained in the Ohio River Basin procedures below).

If the effluent toxicity does not exhibit reasonable potential, assess the discharge using the Ohio River Basin procedures to determine if Category 3 monitoring should be included in the permit, or whether Category 4 conditions are appropriate (using the procedures in OAC 3745-33-07(B).

Ohio River Basin Procedures

Federal permitting rules require that NPDES permitting authorities limit effluent toxicity when they find that toxicity has the "reasonable potential to cause or contribute to exceedances of WQS" [40 CFR 122.44(d)]. This rule also requires permitting authorities to develop methods to decide when reasonable potential exists. The state rules listed in the heading of this guidance are Ohio's methods for implementing the federal rule. Ohio's permit rules contain a scaled review of toxicity. Dischargers are rated according to their toxic potential, and placed in one of four hazard categories, with permit requirements that decrease as the toxic hazard decreases [OAC 3745-33-07(B)]. Category 1 dischargers are considered to exhibit reasonable potential, and must be given toxicity limits; Category 2 dischargers have reasonable potential based on a limited amount of data (fewer than 6 sample results); these dischargers are given limits, and a period of more frequent monitoring to show that the limits included in the permit are or are not necessary. Instead of monitoring frequently and including limits, the permit rule allows you to include a plant performance evaluation. This gives the discharger an incentive to investigate potential sources of toxicity immediately, rather than waiting for a year or more of test results; Category 3 dischargers do not exhibit reasonable potential, but do show enough effluent toxicity to warrant a monitoring requirement; and Category 4 dischargers do not show any potential for toxicity problems.

Environmental Indicators

Is the discharge having a toxic effect on the stream? We may have a variety of data that relates to this question - effluent and instream toxicity test data, instream biosurvey data, effluent chemistry data, and information on discharge frequency and treatment plant performance. How we weigh each type of data depends on how reliable the data is (quality), how well it shows the effect of the effluent on the stream (descriptiveness), and how good an indicator of the instream biological community it is.

This latter point probably needs more explanation. The Clean Water Act [Section 101] refers to restoring and maintaining the "biological integrity" of the nation's waters. The aquatic life use designations in the WQS show our expectations of "biological integrity" for different types of waterbodies. It would be very difficult to measure the complete "biological integrity" of a waterbody because of the complex connections between all of the different biological communities involved (algae, plankton, plants, macroinvertebrates, fish, amphibians, etc.). Because we can't do this perfectly, we develop indicators of environmental quality, such as measuring chemical quality to compare with ambient WQS, or measuring the effect of a discharge with chemistry or toxicity data.

The closest measures of "biological integrity" that we have developed so far are the biological criteria that are listed at the end of OAC Rule 3745-1-07. These involve measurements of the fish and macroinvertebrate community characteristics. Because these communities are at the highest levels of the aquatic food web, measurements of these communities will incorporate many of the effects that occur to organisms lower in the food web, making them very good indicators of biological integrity. Biological indices can also measure effects that occur over time, as well as those occurring at the time of sampling, because the organism communities continually inhabit the stream.

USEPA and the states have reviewed a lot of the environmental indicators that are used to assess water quality and permit program effectiveness, and have developed a hierarchy that shows which indicators are closest to measuring biological integrity. The list and hierarchy are shown on the attached figure. Note that the indicators go from purely administrative indicators at Level 1 to more true environmental indicators at Levels 5 and 6. This does not mean that the higher level indicators are necessarily more useful in permit decision-making. Lower level indicators may, at times, be more descriptive of instream conditions at a given point in the receiving water.

We evaluate the data from different indicators using the attached worksheet (Table 1). The worksheet is also at the end of OAC Rule 3745-33-07. It contains attributes/data related to effluent toxicity, near-field factors (toxicity/chemistry/biology), and far-field factors (toxicity/biology). The idea is to review biosurvey data together with effluent indicators like toxicity, chemistry and plant operations to develop plausible cause-and-effect relationships data on the effluent and the instream biota. The different indicators in this matrix are qualitatively weighted, based on the hierarchy of environmental indicators, to arrive at the permit requirements appropriate to discharge/receiving water assessment. To assess all factors related to toxicity, you need to evaluate the worksheet for acute and chronic toxicity separately. For any given attribute, you may have an indicator that overlaps more than one category.

Review of Effluent Toxicity (Attribute A Factors)

This section of the table is a worksheet that Permits staff need to fill out. There are spaces to input the number of tests, the percentage of tests that exceed the WLA value. One test date is considered one sampling event, no matter how many test species were used, or endpoints assessed during that event. In the worksheet table, highlight the possible categories that the discharge could fall into.

Next, you'll need to calculate the geometric mean of the effluent samples for each species tested. Use 1.0 TUc for chronic test results that show no chronic toxicity. For acute tests, use the following table to approximate TUa values for effluent test results less than 1.0 TUa:

TUa	Percent Mortality in 100% Effluent
0.9	45
0.8	40
0.7	35
0.6	30
0.5	25
0.4	20
0.3	$\leq$15

Next compute the average exceedance factor by multiplying the percentage of samples that exceed the WLA by the geometric mean TU (do this for both acute and chronic toxicity and for both test organisms - 4 calculations in all). Determine which species is more sensitive for acute and chronic toxicity (which has the higher average exceedance factor). You may have an acute exceedance factor based on one species' data, and a chronic exceedance factor based on another species' data.

Compare these factors to the numbers in the columns and highlight the appropriate column for the average exceedance factor. Use the "With B and C Available" factors if there is biosurvey data available to assess the discharge. Otherwise use the "Without B and C Available" factors.

In the Maximum TU area, mark the appropriate column by comparing the highest acute and chronic TU values recorded in the database to the factors. Use the "With B and C Available and Confirming Toxic Impact" factors if there is a biosurvey available and the survey data indicates a toxic impact. This information should be available in Permit Support Documents or Biological and Water Quality Reports. If these aren't available, or you're not sure, check with the Ecological Assessment Unit or district Water Quality Unit staff. If this 'toxic impact' condition is not met, use the "Without B and C Available" factors.

Review of Near-field Data (Attribute B Factors, Relevant to Acute Toxicity Only)

These indicators are meant to help assess whether or not there is lethality within a mixing zone or near-field area close to a discharge. They're to help assess whether the "no rapid lethality" narrative WQS [OAC 3745-1-04(D)] is being met.

Compare each individual near-field data point with the mortality listed for each column. Do not consider mortality that is totally related to upstream control toxicity (that is, when the effluent is non-toxic, but upstream and near-field are). Note this as a stress factor, however, for use in Attribute C. Highlight the appropriate category(ies) for this factor.

The next two factors are basic comparisons - compare individual, or PEQmax effluent chemical values (individual when <10 samples, PEQmax when ≥10), vs. inside-mixing-zone maximum WQS, and compare individual effluent acute toxicity values vs. 1.0 TUa and highlight the appropriate categories in the table.

At times, you will have only chemical data to make this assessment. Because our WQS for toxicity are narrative, rather than numeric, we may simply implement maximum WLA values for chemical parameters if controlling these parameters is protective of acute toxicity standards (see 40 CFR 122.44(d)(1)(v) and the Attribute B indicator for chemical criteria in OAC 3745-33-07, Table 1).

In cases where a pollutant has the reasonable potential to cause acute toxicity and there is no water quality criterion for that pollutant, permit writers are still expected to include limits in the permit, using either a state-generated or federal water quality criterion or set limits on an indicator pollutant (including acute toxicity – see 40 CFR 122.44(d)(1)(v)). This situation occurs most often with total dissolved solids, which has no acute criterion. We use acute toxicity to evaluate these pollutants based on one or both of the following criteria:

1. If TDS concentrations in the discharge are 3000 mg/l or above (based on mostly sodium and calcium chlorides in the ionic mix), acute toxicity is highly likely to occur (95% probability). This is based on TRE studies conducted by Cristal Global for their inorganic chemical process discharges; or

2. If sulfate, chloride or other TDS constituent concentrations exceed LC50 values, acute toxicity to sensitive aquatic organisms (specifically mayflies) is probable, based on the equivalence of LC50 values to Inside-mixing zone maximum (IMZM) water quality criteria. In reviewing LC50 data consider the receiving water's designated use and which organisms are likely to be present in waters with that use designation.

If we determine that there is reasonable potential based on one or more of these criteria, the Attribute B assessment will indicate that we should include in a permit either toxicity limits, or toxicity monitoring with a trigger for action based on exceedances of 1.0 TUa (see categorizations and off-ramps below). Discharges should be rated Category 1 for acute toxicity in this metric if TDS concentrations are 3000 mg/l or higher, and the anions in the discharge are mostly chloride. Category 1 for this metric should also be triggered by sulfate concentrations greater than LC 50 values. Category 2 for this metric should be selected if TDS concentrations are 2000-3000 mg/l, or if sulfate concentrations are $\geq$ LC50.

The biosurvey assessment (inside mixing zone data only for this attribute) will come from the Permit Support Document or Biological and Water Quality Report in most cases. If there's no PSD, consult EAU or the district WQ staff to obtain any applicable data. Remember that the biocriteria listed in OAC Rule 3745-1-07 do not apply within mixing zones. The assessment is based on determining if the community response indicates a toxic exposure. Macroinvertebrate data is a particularly useful tool here, because these organisms are relatively stationary, and reflect localized conditions well. EAS or district WQ staff expertise will likely be needed to determine whether the near-field data show toxic conditions.

Review of Ambient Data (Attribute C Factors – Primarily Chronic Toxicity Evaluations)

These indicators are designed to help determine whether biological communities in the receiving water are being impaired by toxicity. The first comparison is the downstream biological index measurements vs. biocriteria. This is normally done by the ecological assessment unit. The biocriteria indicators tell us the degree of quality or impairment in the fish and macroinvertebrate communities, and often give us insights into the type of impact and the source.

Far-field data can also be used as an indicator of impairment. Comparing adverse effects measured downstream to a no-effect measure, like an NOEC, gives some insight into the persistence of toxicity in the stream; however, this type of data is highly variable in quality, because it depends on the ability to accurately find the edge of a mixing zone. To be accurate, there needs to be a statistically significant amount of effluent/receiving water data to establish a relationship between the two.

Stress indicators can be a lot of different things, from different levels on the indicator hierarchy. Indicators of stress include fish health metrics such as DELT anomalies, adverse biomarker results, non-significant departures from biocriteria measured downstream from the discharge, toxicity observed in upstream WET samples, sediment contamination, a high frequency of spills or fish kills in the stream segment, inconsistent plant operations, etc.

Several of these indicators will come only from the biological survey data. DELT anomalies refer to the level of external deformities, eroded fins, lesions and tumors found on fish. The deformity and tumor levels are particular indicators of toxic stress. Biomarker data is usually taken only in waterbodies where toxicity is expected. These are measures of blood urea-nitrogen levels and/or liver enzyme levels. High levels in these tests indicate that fish are trying to de-toxify some material that they're taking in.

Putting it Together (using the EI hierarchy in a weight-of-evidence evaluation)

This is really two evaluations-one to evaluate whether the discharge is contributing to ambient (outside-mixing-zone) toxicity, and another to determine whether the discharge is contributing to rapidly lethal conditions within the near-field area.

Let's look at the ambient evaluation first. Based on the indicator hierarchy you'd look first at the Attribute C indicators (because these are the highest level indicators). If biosurvey data exists, what does it say about the stream and the discharge? Is there a discernable impact? What type? Any indications of toxic stress? What types of stress indicators exist? A listing of stress indicators according to the indicator hierarchy might look like this:

DELT anomalies	Level 6
ns-Departures from biocriteria	Level 6
Biomarker data	Level 5
Fish Tissue data	Level 5
Sediment data	Level 4
Upstream WET data	Level 4
Spills/Kills	Level 3
Plant Operating Performance	Levels 2-3

Far-field toxicity data is not often available. If it is, you'll want to check where this point is relative to the discharge, and how the site was picked. Check the conductivity data against upstream and effluent values. These checks will let you know if the effluent was well-mixed before the sample was taken, and if the sample was close enough to the discharge to ensure that there is no toxic zone across the stream.

These Attribute C indicators are the higher level indicators (Levels 4-6), and should be given a lot of weight in the analysis. If these indicators show potentially toxic impairment in the stream, and the effluent (Attribute A) indicators show that exceedances of the WLA are possible, then the highlighted factors should be mostly in Category 1, and limits are needed. If there is very little effluent data, or if most of the Attribute information lines up in Category 2, then one of the Category 2 permit conditions would be needed.

A Category 1 designation requires limits on toxicity. The permit conditions (compliance schedule) may require the discharger to perform a Toxicity Reduction Evaluation (TRE) to reduce toxicity to meet the limits. A TRE includes an evaluation of treatment plant capacity and operations, process and influent flows, and may include a Toxicity Identification Evaluation (TIE). A TIE is a hierarchical laboratory procedure for isolating different types of pollutants that may be contributing to the effluent toxicity. Once the TIE identifies the characteristics of the toxic agent(s), the permittee may proceed to try and identify the specific cause of toxicity, or may design treatment based on the characteristics of the toxic agent(s). Note that TREs are not necessarily required in Category 1 permit language. If a permittee has another reasonable method for dealing with toxicity (e.g. pollution prevention), the TRE requirements may be omitted from the permit.

All permits for dischargers in Category 1 must contain the appropriate toxicity limits [OAC 3745-33-07(B)]. These permits will also have compliance schedules (usually 3 years) to come into compliance with limits. Compliance schedules may be extended if the discharger has difficulty identifying the toxicants or their characteristics [OAC 3745-33-05(G)]; however, compliance schedules cannot extend beyond 5 years after a discharger is found to exhibit reasonable potential. (This will be the permit effective date for Category 1 dischargers or the date that a TRE of compliance schedule is triggered for Category 2 dischargers.)

Category 2 dischargers are usually required to monitor for toxicity for one year. The permit contains toxicity limits in the final effluent table that take effect 56 months after the effective date of the permit. At the end of the one-year monitoring program the data is reviewed, and the reasonable potential decision-making process is re-done. If the data indicates that the discharge exhibits reasonable potential, the Ohio EPA triggers a TRE or other compliance schedule (using Findings & Orders) and the limits remain in the permit. The 56 months provides time for testing, evaluation and toxicity reduction before the limit becomes effective. If the discharge now falls into Category 3 or 4, the permit limits are removed from the permit via a permit modification, and if Category 3, appropriate monitoring requirements are included for the remaining life of the permit.

If the discharge remains in Category 2 in this re-rating, the discharger will need to conduct a plant performance evaluation. This evaluation represents the initial stages of a TRE, and is designed to find operational and easily identified influent sources of toxicity. This process should identify most toxicity problems in this category. Dischargers remaining in Category 2 after a re-rating are generally those that experience infrequent, but significant, effluent toxicity. This pattern suggests an inconsistency in plant influent characteristics or treatment plant operation. The plant performance evaluation is geared to solve these types of problems.

Note that a Category 2 discharger may request to conduct a plant performance evaluation in place of the more intensive one-year monitoring program and limits. This is to encourage dischargers to evaluate discharges that are borderline problems, rather than waiting for definitive results (and a finding of reasonable potential).

If the Attribute C factors indicate no toxic impact, but there is still an indication of effluent toxicity greater than the WLA, look for reasons why this might be true (the quality and descriptiveness of the data). Is the effluent assessment based on one toxic event? Was the biosurvey data point further downstream than the edge of the mixing zone might be? The better quality data should guide your judgment in these cases. There is usually at least one way to explain how all the observed data can be true. For example, if the discharge exhibits periodic toxicity greater than the WLA with this type of Attribute C data, where does the effluent attribute data fall in the chart? Effluent attributes that are mainly in the Category 1 and 2 columns may indicate that a plant performance evaluation would be appropriate. If the effluent attributes are more in Category 2-3, a Category 3 monitoring program would be more appropriate.

If there is no biosurvey data, then you won't have many factors in Attribute C to work with.

In this case, you'll be working only with the Attribute A factors. Note that the average exceedance factor becomes more restrictive in this case to compensate for the lack of survey data.

To assess the potential to exceed rapid lethality WQS within the near-field area, you'll be using the Attribute A and B factors. The Attribute B factors are the more direct measures of lethality. Biosurvey data would provide the input for the "Measured Biologically" factor. Again, look closely at the macroinvertebrate data here (they're less mobile than fish). The "Mortality within Mixing Zone" factor is a measure of mortality in near-field samples from toxicity tests of the receiving water.

The other factors in Attribute B are effluent information designed to get at the question of rapid lethality. The 1.0 TUa value represents 50% mortality in 100% effluent - a standard measure of lethality. IMZM chemical criteria are acute criteria with very few safety factors, and can be considered measures of lethality in some portion of the near-field area.

In weighing these factors, look at the indicator level and the quality and descriptiveness of the indicator. Biosurvey data is the highest level indicator, but does not distinguish between acute and chronic toxicity (because you don't know how much exposure time caused the observed effect); near-field bioassay is next, although its quality depends on how well the effluent plume is tracked during sampling (see the conductivity data to determine this). Use the Attribute A factors to help evaluate the potential for effluent toxicity. With chemical parameters (the lowest level indicator): How many parameters exceed IMZM? How often? Although the lowest level indicator, chemistry may have a very high quality because it is usually sampled often.

The WET reasonable potential rule contains several provisions that can be used to modify limits initially capped at 1.0 TUa. Under paragraph (B)(5) of OAC 3745-33-07, acute toxicity limits can be modified based on an Area-of-Initial Mixing (AIM) study, a correlation of effluent and near-field toxicity data that indicates that the narrative WQS will be attained at a defined effluent toxicity greater than 1.0 TUa, or if biological survey results show a non-toxic result in near-field sampling runs. Note that these evaluations can be used for both Lake Erie Basin and Ohio River Basin dischargers.

AIM studies are covered in detail in OAC Rule 3745-2-08. These studies require that the effluent be discharged at a velocity sufficient to create a small uninhabitable zone within the mixing zone. Dischargers are required under this rule to submit an analysis of pollution prevention and treatment options before requesting an AIM. This may not always be practical for WET, because the discharger may not know what is causing the toxicity; however, at least an assessment of treatment plant processes and chemicals added to the discharge should precede the AIM submittal to make sure that easily identified and implemented options are not ignored. Another factor to evaluate in deciding if an assessment is practical is the level of acute toxicity in the effluent – low to moderate levels of acute toxicity may not be practical to assess before requesting an AIM; for high levels of acute toxicity, some assessment of treatment and pollution prevention is reasonable.

Effluent and near-field instream data can be used to support an acute toxicity limit greater than 1.0 TUa, if there is a statistically significant number of concurrent effluent and instream results, and if those results indicate a relationship between effluent toxicity and toxic response in the near-field area [OAC 3745-33-07(B)(5)(b)]. Be sure to check the quality of the near-field results, using conductivity to track the percentage of effluent in the near-field samples. Near-field samples should have substantially more effluent than the ambient samples. Use the following equation to determine the percentage of effluent in the near-field samples:

$$\%\ \text{effluent} = \frac{\text{near-field cond. - upstream cond.}}{\text{effluent cond. - upstream cond.}} \times 100$$

A special case in this category is water treatment plant discharges and other discharges of TDS that are very small with respect to the receiving stream and overall mixing zone. These discharges often contain acutely toxic concentrations of TDS, particularly chlorides and occasionally hardness. Federal guidance does allow NPDES authorities to grant very small areas that do not meet applicable acute toxicity standards if the area is small enough that organisms will not be exposed to acute toxicity long enough to be affected [Federal TSD for Water Quality-Based Toxics Control, 1991, p. 33]. For most dischargers, Ohio EPA believes that it is cost-effective to install a diffuser, conduct a near-field biological survey, or correlate effluent toxicity and near-field toxicity. To determine which facilities have an insignificantly small mixing zone, you should consider:

- The discharge volume vs. the stream flow used in the acute WLA (rivers);
- The absolute size of the area that could be acutely toxic, and whether it is habitable by macroinvertebrates; and
- The effluent TDS concentrations and how likely they are to be acutely toxic.

Near-field biological survey data can also be used to set alternate acute toxicity limits if the biosurvey data shows a non-toxic response. This situation will not arise often because in most situations where the biosurvey data shows no toxicity, because most dischargers in this situation will be in Category 2 or 3. However, in the highly unusual case where effluent toxicity is consistently greater than 1.0 TUa in combination with non-toxic near-field biosurvey results, the rules allow us to establish effluent limits greater than 1.0 TUa that would protect the narrative WQS.

Paragraphs (B)(8) and (9) of OAC Rule 3745-33-07 allow us to modify toxicity limits based on the ambient (outside-mixing-zone) WLA under the following circumstances. First, if a discharger has substantially reduced effluent toxicity, but has not met the WLA, and if biosurvey data taken after the toxicity reduction shows attainment of the stream use, then we can base effluent toxicity limits on the level of toxicity being discharged at the time of the survey, rather than on the WLA value.

The (B)(9) language applies only to waters designated LRW in the WQS. If habitat conditions are so severely degraded that even communities associated with the LRW use are precluded from the water body, we can develop alternative TUa limits based on the toxicity level necessary to protect the organisms that could inhabit the water body.

Examples

Example 1 - Discharge-dominated stream (WLA = 0.3 TUA, 1.0 TUc)

Biosurvey Data (WWH)

IBI	Mod Iwb	ICI	QHEI	Attainment	Site
27*	NA	30^{ns}	68.5	PARTIAL	Ecoregion Ref. Site
35*	NA	30^{ns}	78.5	PARTIAL	Upstream
22*	3.6*	--	58	(NON)	Flow modified
--	--	P	--	(NON)	Effluent backwater
24	5.0	VP	--	NA	Effluent mixing zone
28*	4.8*	8	80	NON	Downstream

* = significant departure from biocriteria; ns = non-significant departure from biocriteria; underlined values are in the poor/very poor range.

Effluent Toxicity Data

Acute - 31 *Ceriodaphnia* tests; 30 were toxic and exceeded the WLA (values ranged from 1.1 to 40.8 TUA); 17 fathead minnow tests - none toxic.

Chronic - 7 *Ceriodaphnia* tests - all exceeded WLA (values ranged from 2.8 to 40.8 TUc); 5 fathead minnow tests - none toxic.

Working through the matrix it should be obvious that this is a Category 1 discharger, and therefore would need toxicity limits under OAC Rule 3745-33-07(B). All of the effluent toxicity attributes should line up in the Category 1 column, and the ambient indicators in Attribute C should show the same pattern. The effluent exceeds the WLA for Ceriodaphnia toxicity in virtually all samples, and the ICI data indicates that the discharge is clearly toxic to macroinvertebrates.

Example 2 - Discharge-dominated stream - (WLA = 0.36 TUA, 1.0 TUc)

Biosurvey Data (WWH)

IBI	Mod Iwb	ICI	QHEI	Attainment	Site
26*	NA	40	67.5	PARTIAL	Upstream
23*	NA	4	72	NON	Effluent mixing zone
24*	NA	P	48.5	NON	Downstream
31*	NA	20*	76	NON	2 Miles downstream
33*	7.0*	38	70.5	PARTIAL	4 Miles downstream

Effluent Toxicity Data

Acute - 13 tests; no toxicity to fathead minnows; 3 of 13 *Ceriodaphnia* tests exceeded WLA (1.2 to 2.8 TUa).

Chronic - 10 tests; no toxicity to fathead minnows; 7 of 10 *Ceriodaphnia* tests exceeded WLA (1.1 to 5.6 TUc)

In this case the number of chronic exceedances coupled with the poor macroinvertebrate community downstream warrants a Category 1 permit requirement. Many of the effluent toxicity attributes will also line up in Category 1.

Example 3 - Large dilution scenario (WLA = 7.9 TUa, limited to 1.0 TUa to protect against rapid lethality within the mixing zone)

Biosurvey Data - None (WWH)

Effluent Toxicity Data
Acute - 41 tests: 2 of 41 fathead minnow tests exceeded 1.0 TUA (1.1 to 1.3 TUA) ; 32 of 41 *Ceriodaphnia* tests exceeded 1.0 TUA (1.1 to 3.85 TUA).

In this case, the *Ceriodaphnia* results indicate the reasonable potential to exceed the "no rapid lethality" WQS at some point in the mixing zone. This discharger would fall into Category 1 based on the number and level of exceedances of 1.0 TUa, and would require limits in the permit.

Example 4 - Medium dilution scenario (WLA = 5.9 TUc, 1.0 TUa needed to protect against rapidly lethal conditions)

Biosurvey Data (WWH) – No mixing zone sample					
IBI	Mod Iwb	ICI	QHEI	Attainment	Site
51	8.9	42	78	FULL	Upstream
53	9.1	44	78	FULL	Downstream
41^{ns}	8.7	44	71	FULL	3 Miles downstream

Effluent Toxicity Data
Acute - 3 tests; fathead minnow data - 2.4 TUA, 1.8 TUA, <1.0 TUA; Ceriodaphnia data - 4.4 TUA, 1.3 TUA, 0.6 TUA; no mortality in mixing zone samples taken 5-12 feet from the outfall ditch; conductivity data shows very little effluent in the mixing zone samples.

In the far-field/ambient analysis, all of the indicators will line up in Category 4, because none of the effluent results exceed the ambient WLA, and the receiving water is attaining its use. In the mixing zone/near-field analysis, all of the effluent indicators will register in Category 1 because of the frequent exceedance of 1.0 TUA; however, the ambient indicators from Attribute B fall largely in Categories 2/3. The fact that mixing zone samples collected that close to the outfall contained so little effluent indicates that the discharge mixes more quickly than is visibly apparent. If there is an effect instream, it will be in a very small area. The "implied chemically" indicator also falls in the Category 2/3 range based on periodic exceedances of Inside-mixing-zone maximum WQS (TDS, Zn, hex. chrome and possibly aluminum).

We would place this discharge in Category 2, based on these results. The discharge quality is somewhat erratic based on the chemical and WET results, but there isn't a measurable consequence to the mixing-zone/near-field area. The fact that the effluent consistency could be improved makes this discharger a good candidate for a plant performance evaluation to correct the effluent problems before they have a measurable impact on the stream.

Example 5 - Large dilution scenario - poor mixing (WLA = 48.7 TUc, 13.6 TUA, 1.0 TUA needed to protect against rapidly lethal conditions within the mixing zone)

Biosurvey Data (MWH)					
IBI	Mod Iwb	ICI	QHEI	Attainment	Site
30	8.1	--	57	FULL	Upstream
34	8.7	--	46.5	NA	Effluent mixing zone
33	8.3	--	46	FULL	Downstream

Effluent toxicity data

Acute - 3 of 11 fathead minnow tests toxic (1.25-1.7 TUA); 11 *Ceriodaphnia* tests - no toxicity.

Chronic - 7 of 9 fathead minnow tests toxic (1.12-2.36 TUc); 4 of 9 *Ceriodaphnia* tests toxic (4.17 - >10 TUc). Some far-field tests show significant mortality (20-30% - both organisms).

For the acute toxicity (IMZM) evaluation, the balance of the indicators line up in Category 3: The maximum TU value, mortality within mixing zone, and implied toxicologically (1,2,3) align primarily in Categories 2/3. The average exceedance and near-field biosurvey indicators clearly line up in Category 4. This data seems to indicate that the magnitude and frequency of acute toxicity >1.0 TUA is not sufficient to cause an impact.

The chronic assessment depends on the mixing assumption used. The WLA above uses 100% of the stream to calculate limits; this contrasts with the poor mixing observed in the field. The downstream biosurvey site, approximately 1000 feet downstream of the discharge, did not show a toxic response in the fish community; however, the actual size of the mixing zone would be needed to determine if the discharge is actually meeting the WLA. This permit contained a mixing zone study to determine whether the mixing at the edge of the zone would allow the discharge to meet WLA values, in addition to a Category 3 monitoring program for WET.

Example 6- Large dilution scenario (7.8 TUA, with 1.0 TUA needed to protect against rapidly lethal conditions within the mixing zone, 29 TUc)

Biosurvey Data (WWH)					
IBI	Mod Iwb	ICI	QHEI	Attainment	Site
31*	8.7	54	68	PARTIAL	Upstream
25	8.5	18	67.5	NA	Effluent mixing zone
37*	9.4	38	70.5	PARTIAL	Downstream
36*	9.1	--	81	[PARTIAL]	1.7 Miles downstream
39^{ns}	9.9	48	82.5	FULL	5 Miles downstream

Effluent Toxicity Data
Acute - 3 tests showed no adverse effect
Chronic - No data

Because the three acute toxicity tests showed no adverse effect, all of the effluent attributes will line up in Category 4; the effluent-related near-field indicators also line up in Category 3/4. The biosurvey indicators show a somewhat different picture. Near-field results decline markedly for macroinvertebrates, and slightly for the fish (IBI index). The far-field macroinvertebrate results also indicate stress, in that ICI scores do not return to ambient levels, as measured by upstream and downstream results. These indicators line up primarily in Category 2 for near-field results, and Category 3/4 for far-field.

There are at least two explanations for these results: It may be that the effluent acute toxicity is sporadic and significant (as measured by the ICI near-field results), and was not present during the three toxicity sampling runs. It is also possible that the macroinvertebrate scores are the result of continuous exposure to the effluent's chronic toxicity, which was not tested. This is an important distinction because the first case represents a violation of WQS, while the second does not. The biosurvey results in this case cannot distinguish between acute and chronic toxicity because the organisms are continuously exposed to the effluent. The biosurvey indicators, which are both higher level and more robust in quality in this case, indicate that, while reasonable potential does not exist because of the effluent and far-field data, the potential for near-field exceedances should be investigated. The discharger should therefore be given a Category 3 monitoring program to determine whether the near-field ICI results are due to acute or chronic toxicity.

Administrative

Level 1	**Actions by EPA and States**	NPDES Permit Limit History Compliance/Enforcement Actions Pretreatment Program Approvals/Reviews Actual Funding CSO Requirements Storm Water Permits 319 Nonpoint Source Projects 404/401 Permit Actions Local Stream/Riparian Protection Actions
Level 2	**Responses by Regulated Communitiy**	Local Limits POTW Construction Storm Water Controls BMPs for Erosion Control BMPs for Nutrient Management
Level 3	**Changes in Discharge Quantities**	Point Source Loadings - Effluent Point Source Loadings - Influent Whole Effluent Toxicity (WET) NPDES Violations Toxic Release Inventory Spills Fish Kills
Level 4	**Changes in Ambient Conditions**	Water Column Chemistry Sediment Chemistry Habitat Quality
Level 5	**Changes in Uptake and/or Assimilation**	Assimilative Capacity - TMDL Biomarkers Tissue Contamination
Level 6	**Changes in Health and Ecology, or Other Effects**	Bacterial Contamination Biota Target Assemblages

True Environmental

Table 1: Criteria For Potential Environmental Hazard Categories

Attribute Evaluated	Category/Degree of Toxicity Problem			
	1 Adequately Documented	2 Strongly Suspected	3 Possible	4 None
A: Effluent Toxicity Minimum Number of Tests (Actual # ___)	3	1	0-1	0-1
% of Tests >WLA (Actual % ___)	>30	20-30	10-20	<10
Effluent Geometric Mean TU TUA (___) TUC (____)				
Average Exceedance				
Without B and/or C Available				
Acute[b]	>0.3	≥0.3	≥0.2	<0.2
Chronic	>0.3 x WLA	≥0.3 x WLA	≥0.2 x WLA	<0.2 x WLA
With B and/or C Available				
Acute[b]	>0.5	≥0.3	≥0.3	<0.3
Chronic	>0.67 x WLA	≥0.5 x WLA	≥0.5 x WLA	<0.5 x WLA
Maximum TU value				
Without B and/or C Available	≥3 x WLA	≥1 x WLA	≥1 x WLA	<1 x WLA
With B and/or C Available And Confirming Toxic Impact	>1 x WLA	≥1 x WLA	≥0.5 x WLA	<0.5 x WLA
B: Near-field Impact Mortality Within Mixing Zone	≥20%	≤20%	≤20%	<20%
Stream Community Impact Within Mixing Zone				
Implied Chemically[d]	≥3 x IMZM	≥1.5 x IMZM	≥ IMZM	≤0.5 x IMZM
Implied Toxicologically[d]	≥1.0 TUa	≥1.0 TUa	≥1.0 TUa	<1.0 TUa
Measured Biologically	Toxic or Severe Unknown Signature	Fair/Poor Community	Slight Impact or Unknown Impact Signature	None or Non-Toxic Signature
C: Far-field Impact Aquatic Life Use Impairment (Ohio EPA Biological Criteria)	Yes[e]	Yes or Partial[e]	Partial	None or Non-Toxic Signature
Stream Community Impact Implied Toxicologically [c]	Significant Effect	Significant Effect	Unknown or Slight Effect	None
Other Indicators	Stress Indicated	Stress Indicated	Stress Indicated	No Stress

[a] Compare (% Exceedances X Geo. Mean TU) To Table Factor.
[b] Use 0.3 X WLA For Situations Where Aim Exists.
[c] Results Of Ambient Toxicity Test Are Not Binding Or Required For Classification As To Category, But If Available, Will Be Interpreted Under The Weight Of Evidence Principle Giving Due Consideration As To Sampling Location And Conditions.
[d] Based On Effluent Data. May Not Be Appropriate For Situations Where Aim Exists.
[e] Lack Of Attainment Due To Toxic, Complex Or Unidentifiable Type Of Impact.