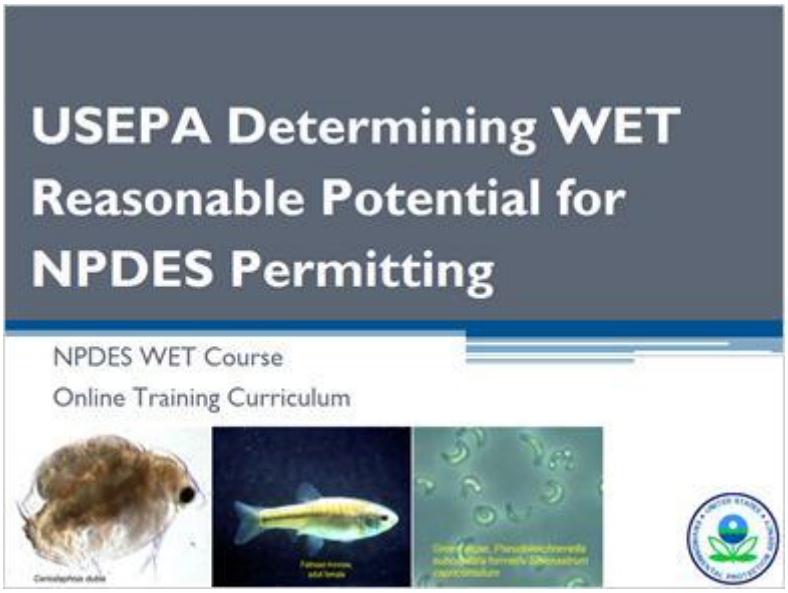
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

Welcome to this presentation on the United States Environmental Protection Agency's, hereafter USEPA, Determining Whole Effluent Toxicity Reasonable Potential for National Pollutant Discharge Elimination System or NPDES Permitting. This presentation is part of a Web-based training series on whole effluent toxicity, or WET, sponsored by the USEPA's Office of Wastewater Management's Water Permits Division.

You can review this stand-alone presentation, or, if you have not already done so, you might also be interested in viewing the other presentations in this series, which cover the use of Whole Effluent Toxicity under the NPDES permits program.

Before we get started with this presentation, I have one important housekeeping item.

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting

Notes:

First, let me introduce myself. My name is Laura Phillips, and I am USEPA's National WET Coordinator with the Water Permits Division within the Office of Wastewater Management at the USEPA HQ in Washington D.C.

Second, now for that housekeeping item. You should be aware that all the materials used in this presentation have been reviewed by USEPA staff for technical and programmatic accuracy; however, the views of the speakers are their own and do not necessarily reflect those of the USEPA. The NPDES permits program which includes the use of Whole Effluent Toxicity testing is governed by the existing requirements of the Clean Water Act and USEPA's NPDES permit implementation regulations. These statutory and regulatory provisions contain legally binding requirements. However, the information in this presentation is not binding. Furthermore, it supplements, and does not modify, existing USEPA policy and guidance on Whole Effluent Toxicity in the NPDES permits program. USEPA may revise and/or update the contents of this presentation in the future.

Also, this module was developed based on the live USEPA HQ NPDES WET course that the Water Permits Division of the Office of Wastewater Management has been teaching to USEPA regions and states for several years. This course, where possible, has been developed with both the non-scientist and scientist in mind, and while not necessary, it is recommended that a basic knowledge of biological principles and Whole Effluent Toxicity will be helpful to the viewer. Prior to this course, a review of the USEPA's

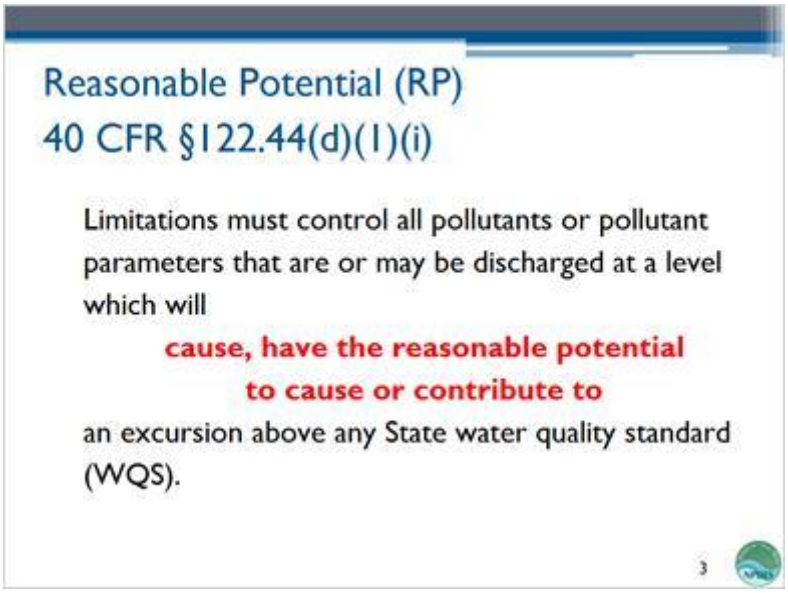
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting

Permit Writer's online course, which is also available at USEPA's NPDES website, is recommended.

When appropriate a blue button will appear on a slide. By clicking this button, additional slides will present information regarding either freshwater or marine USEPA WET test methods. When these additional slides are finished, you will be automatically returned to the module slide where you left off. The blue button on this slide provides the references for USEPA's WET test methods that will be presented throughout this module.

Alright. Let's take a look at the NPDES implementation procedures used to determine reasonable potential, or RP, for Whole Effluent Toxicity.

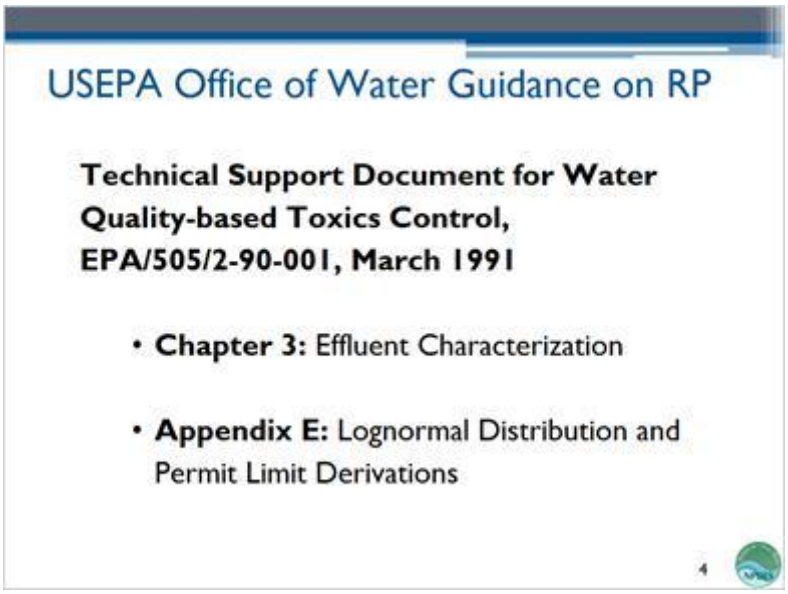
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

USEPA's NPDES regulations for reasonable potential in support of the water quality provisions in the Clean Water Act are listed at Title 40 of the Code of Federal Regulations, or CFR, at Part 122.44(d)(1)(i). These NPDES regulations require that limitations must be in place to control all pollutants or pollutant parameters or toxic pollutants which are determined to be 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.

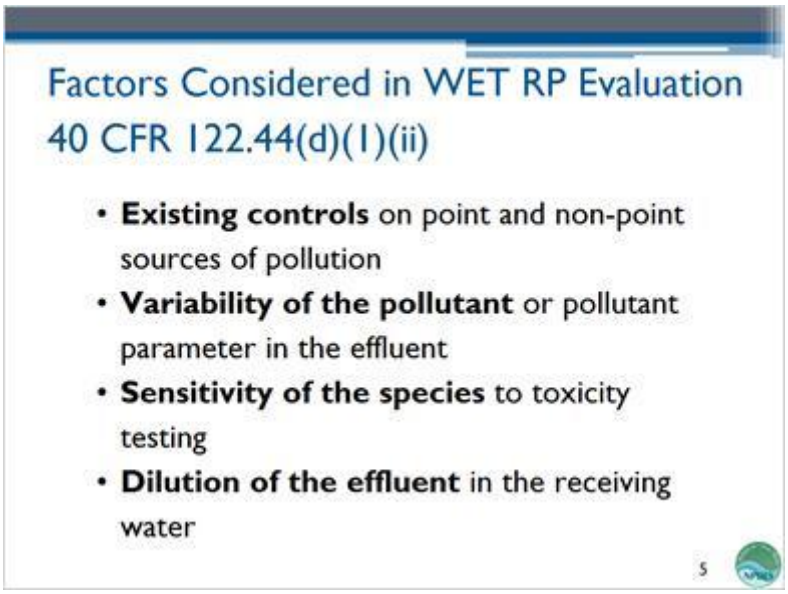
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

USEPA's 1991 Technical Support Document on Water Quality-based Toxics Control, commonly referred to as the TSD, provides guidance on determining RP and is available on USEPA's NPDES website. Chapter 3 of the TSD discusses RP not only for chemical-specific parameters, but also for WET. Appendix E of the TSD discusses log normal distribution of data and the use of this distribution in developing USEPA's guidance for RP analysis and permit limit derivation.

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

40 CFR Part 122.44(d)(1)(ii), shown on this slide, requires that several factors are considered when determining whether a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative or numeric criteria within a state water quality standard. The NPDES permitting authority shall use RP procedures which account for existing controls on point and non-point sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the species to the toxicity testing when evaluating Whole Effluent Toxicity, and where appropriate, the dilution of the effluent in the receiving water. Therefore, to properly characterize a permitted effluent discharge for reasonable potential determinations which are protective of a state's aquatic life protection criteria and WET water quality standards the factors listed on this slide are very important.

The variability of the effluent can be accounted for by careful decisions about an appropriate WET monitoring frequency and WET test type selections that are representative of the permitted effluent. The variability of effluents may be due to several factors, such as, but not limited to: the chemical mixture of the effluent itself and if a mixing zone is allowed under state law, the possible exposure to other chemicals as well as pH, light, or temperature of the receiving waterbody.

Species sensitivity is another critical consideration when selecting the appropriate USEPA WET test species to be used in effluent toxicity testing.

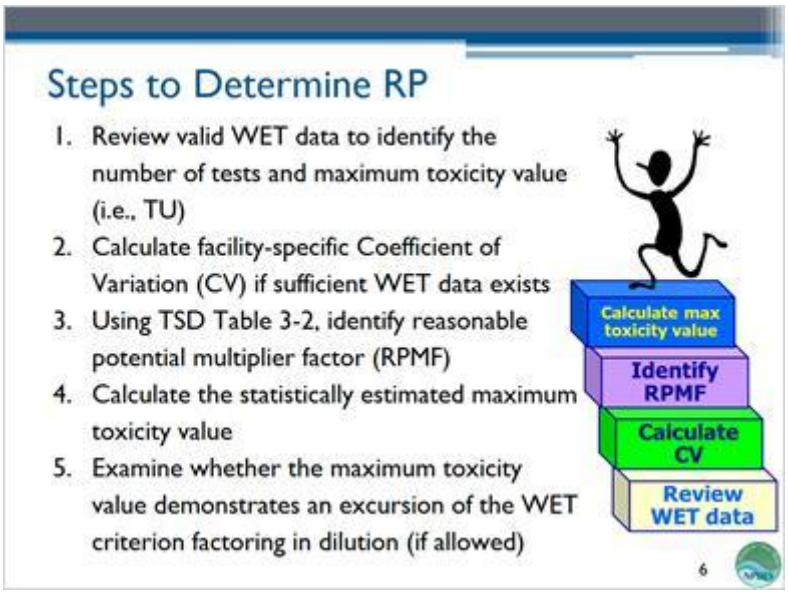
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting

Careful selection of the WET test species ensures that the most sensitive trophic level and species form the basis of a conservative approach towards protecting the state's WET water quality standards. For example, in some cases the freshwater invertebrate water flea, *Ceriodaphnia dubia*, may be more sensitive than the freshwater vertebrate fathead minnow, *Pimephales promelas*. In other cases, a fish may be more sensitive than other WET test species, such as where ammonia is too high in a permitted effluent.

Finally, the available dilution of the effluent in the receiving waterbody can be a critical factor in a reasonable potential determination. The RP analysis determines whether there is enough available dilution in the receiving waterbody such that it is unlikely that a level of toxicity exists that would result in an excursion of a state's WET water quality standard.

So all of these different factors (effluent variability, species sensitivity, available dilution) can affect reasonable potential for an excursion of a state's WET water quality standard, and therefore are incorporated into the RP analysis which will be discussed in more detail in the next slides.

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

The RP analysis begins with having valid WET test data that have met all the USEPA WET Test Acceptability Criteria according to USEPA's WET test methods at 40 CFR Part 136 and also for the USEPA 1995 West Coast WET test methods. See the previous modules on the USEPA's WET test methods and Quality Assurance/Quality Control if you need a refresher on what constitutes valid WET test data.

The first step in making an RP analysis determination is to review the valid WET data generated from WET tests using USEPA's WET test methods as described in the WET test methods module. In reviewing the valid WET test data, the number of tests, referred to later in this module as "N", is going to be identified, as well as the maximum toxicity value observed, which is expressed as toxic units, or TUs. The toxic unit values of the generated WET test data are not averaged, because averaging could lower the maximum toxicity value and therefore may not be protective of the state's WET water quality standard. For the RP analysis, the maximum toxicity value, or TU, is selected.

The second step is to use all of the valid WET test data generated to calculate a facility-specific Coefficient of Variation, or CV, if there is sufficient valid WET test data. If there are less than 10 valid WET test data points for the selected WET test type and species, then, USEPA recommends the default CV of 0.6. When there are 10 or more valid WET test data points, a facility-specific CV should be used.

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting

The third step is to identify the Reasonable Potential Multiplying Factor, or RPMF, using the tables in the USEPA's TSD, specifically table 3-2. The TSD RPMF tables use the number of WET test data points referred to as the number of samples, or "N," and the CV to identify the RPMF. The RPMF will be higher as the number of valid WET test data points decreases as will be demonstrated in the RP analysis example in this module.

The fourth step is to calculate the statistically estimated maximum toxicity value using the RPMF and the maximum toxicity value observed.

The final step is to determine whether the estimated maximum value that was calculated demonstrates the reasonable potential to result in an excursion of the WET criteria taking into account available effluent dilution if a mixing zone is allowed under a state's laws, as previously discussed. If the state's water quality standards or permitting regulations do not allow for a mixing zone, then effluent dilution is not factored into the RP analysis and the state's WET criteria must be met at the end-of-pipe, meaning zero or no dilution. The WET criteria that will be used to calculate the maximum toxicity value are USEPA's recommended WET criteria provided in USEPA's TSD, which are: 0.3 toxic units acute, or TU_a, and 1.0 toxic units chronic, or TU_c.

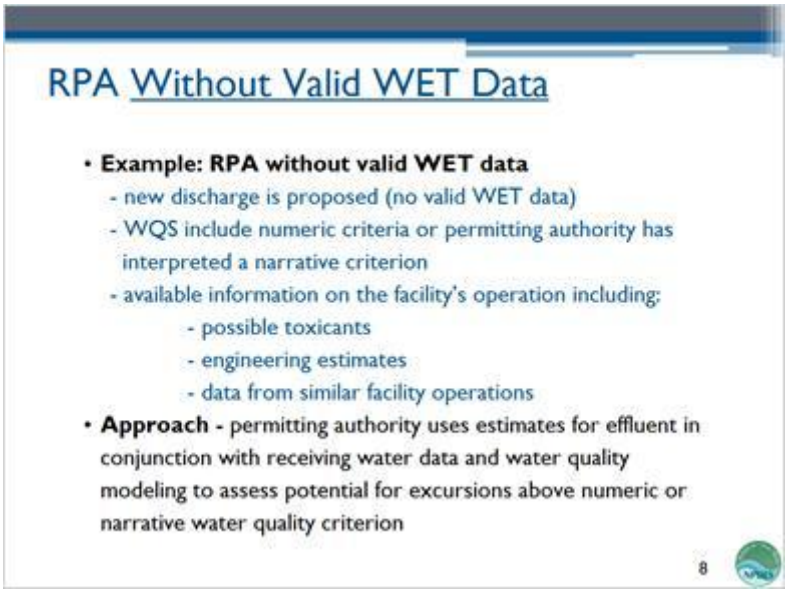
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting

Notes:

USEPA's NPDES regulations require that permitted effluents being discharged into waters of the United States must not violate state WET water quality standards, and therefore a RP determination for the permitted effluent discharge must be completed, whether or not valid WET test data exists. So, how do you analyze RP without valid WET test data? If the effluent is being discharged from an industrial facility, there are several factors that can be included in an RP analysis, such as, but not limited to: what type of industry it is, what types of raw materials are used, and what processes and chemicals are used that might cause toxicity impacts that would need to be evaluated. For example, if it is an industrial facility that uses toxic chemicals such as ammonia, heavy metals, or other chemicals that could be present in the discharged effluent in the receiving waterbody, then the effluent would likely be considered to have RP for an excursion of the state's WET water quality standards and therefore be determined to need a NPDES WET limit. In addition to the types of chemicals and processes used at the permitted facility, the type of wastewater treatment and other process related controls which may be in place to prevent effluent toxicity should be factored into the RP analysis. For example, if the facility has an advanced pretreatment and wastewater treatment system in place, the effluent may have less likelihood of being determined to have RP. Other important information to consider and factor into the RP determination is whether the existing permit has water quality-based effluent limits in place. All of these are some of the types

of facility-based and permit information that permit writers need to consider when making an RP determination without valid WET test data.
For municipal wastewater facilities and Publicly Owned Treatment Works, or POTWs, the important factors to consider for determining RP are: the type of pretreatment program that is in place, the available water quality history including permit compliance, the type of indirect discharges that come into the wastewater facility, the types and frequency of industrial loadings, types of treatment processes used and how advanced it is, other WQBELs in place, and any history of effluent compliance issues. So for example, if chemical-specific NPDES permit limits are being violated, and it is known that some of those violations are chemicals that are known to be toxic to aquatic life, a determination could be made that this facility would have WET RP. Other types of information to consider when making an RP determination include: the receiving water characteristics; for example, sensitive waterbodies such as a trout stream or where endangered species are present; the designated uses, whether the WET criteria are narrative or numeric, whether stream bioassessment data are available, and finally, if there is available effluent dilution. In some states, if the facility discharges to an effluent dominated receiving water, RP is often assumed, especially for those facilities discharging a fairly high effluent flow, for example, greater than 1 million gallons per day. Another factor that may increase the potential for a facility to have RP is if the receiving waterbody is listed on the USEPA's 303(d) impaired waters list under the Clean Water Act. Also, state 305(b) monitoring reports under the Clean Water Act regarding the health of the receiving stream and/or effluents discharging to the stream can also be important factors to consider in determining RP without valid WET data.

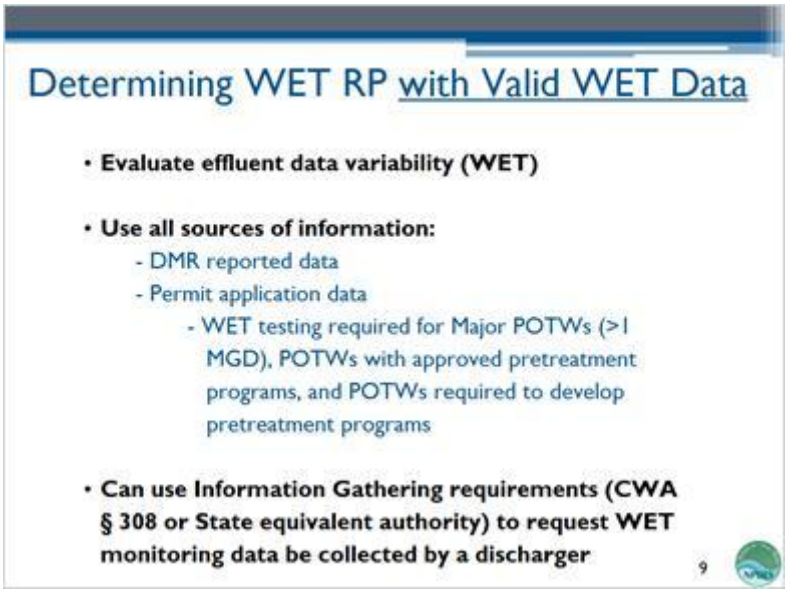
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

In a case where a new NPDES permitted facility and effluent discharge is proposed, there may be no valid WET test data available. Noted in the previous slide, for existing NPDES permitted dischargers, the RP determination approach without valid WET test data is to examine the state's WET water quality standards including both the narrative and/or numeric criteria especially where the permitting authority has interpreted its narrative criteria and to consider all the available facility information. Also, it may be helpful to look at WET test data from a similar type of permitted facility if there is not much information available about the current facility discharge. So, the overall approach is for the permitting authority to use all of the information available regarding the permitted effluent in conjunction with what is known about the receiving water, via actual ambient data or based on water quality modeling, to assess the reasonable potential for an excursion above the state's numeric or narrative WET water quality standards.

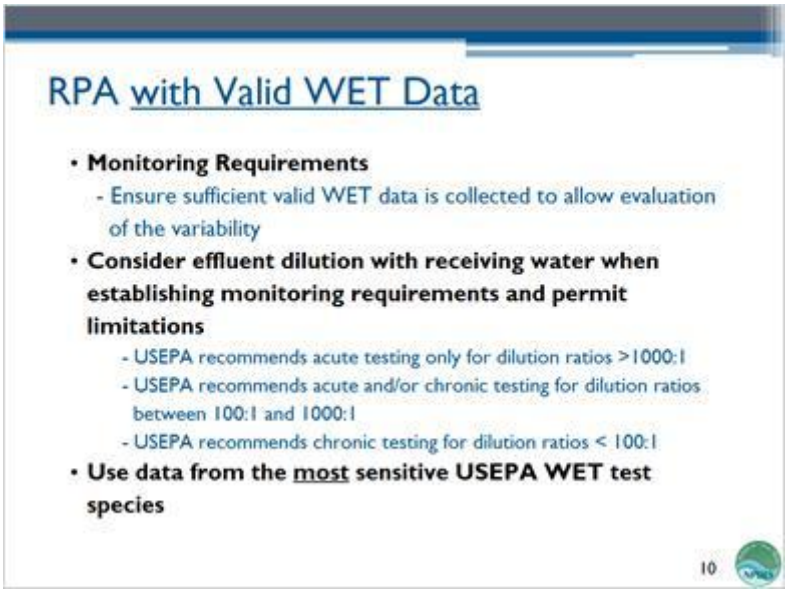
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

To determine WET RP where there is valid WET test data, the approach is to evaluate effluent WET data variability and use all sources of information, including Discharge Monitoring Reports, or DMR, report data, NPDES permit application data, and any other available valid WET test data based on the USEPA's WET test methods and Test Acceptability Criteria, or TAC, as discussed in the WET test methods module. The NPDES permit application may contain relevant information to use in the RP analysis, including: WET test data based on effluent monitoring, which is required for major facilities with a NPDES permit limit, or for POTWs with pretreatment programs, or POTWs that are required to develop pretreatment programs. Also, other information may be available based on the permit writers' access to data or information on the permitted facility under Section 308 of the Clean Water Act for requesting information or data from a permitted facility, and/or state laws that are similar to Section 308 of the Clean Water Act.

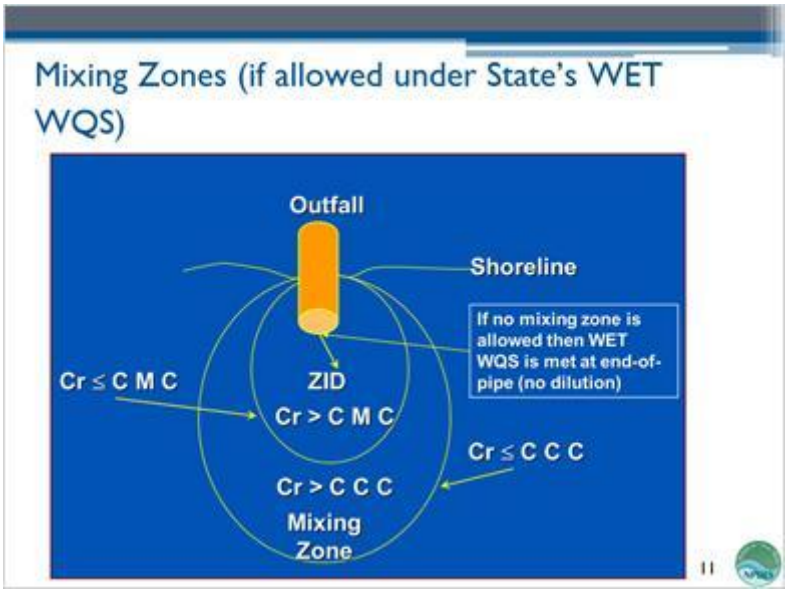
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

When setting effluent WET monitoring requirements in the permit, it is critical that sufficient valid WET test data are collected to properly evaluate the effluent's variability, as mentioned in the previous slide. Many, if not most, effluents are at least somewhat variable in terms of chemical concentration stability over time, so the more valid WET test data available, the higher the confidence in the RP determination. USEPA's TSD provides recommendations for the selection of the type of USEPA WET test based on the available dilution in the receiving waterbody relative to the permitted facility's effluent flow. If the critical receiving waterbody condition represents a ratio of 1000 parts receiving water to 1 part effluent, then USEPA recommends WET monitoring using acute WET testing. If the critical effluent dilution is between 100 to 1 and 1000 to 1 receiving water and effluent, then either acute or chronic WET testing may be appropriate. If the critical effluent dilution is less than 100 to 1 receiving water to effluent, then chronic WET testing is recommended. In addition, as mentioned in the previous slides in this module, valid WET test data from the most sensitive WET test species is used in the RP determination. USEPA recommends, where possible, conducting WET testing using a plant, an invertebrate, and a vertebrate. This is discussed in more detail in the WET test methods module. WET test data based on using the USEPA WET test species that is observed to be most sensitive to the effluent should be used in the RP analyses.

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



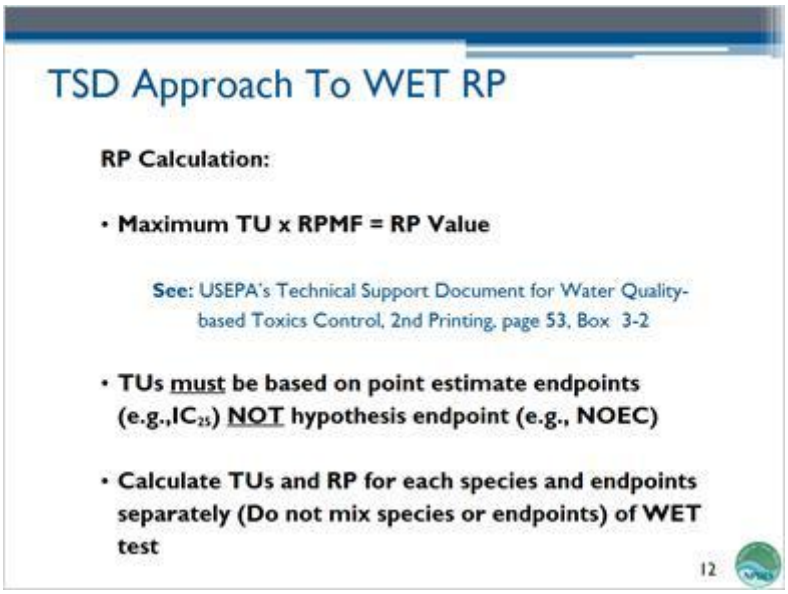
Notes:

For states that allow a mixing zone in their state water quality standards or their state permitting regulations, the figure displayed in this slide is appropriate. If a mixing zone is not allowed under state laws, meaning there is no allowance for dilution, then similar to analyzing RP for a chemical, WET aquatic life protection criteria must be met at the end of the effluent discharge pipe. Assuming mixing zones are allowed under state laws, this figure shows a zone of initial dilution, or ZID, represented by the smaller circle. It is within this smaller circle closest to the effluent discharge pipe where acute effects to aquatic life are examined. Therefore, the ZID is referred to as the acute mixing zone where acute WET test endpoints are considered. The receiving stream concentration, or Cr, is calculated for both acute and chronic RP determinations. In the acute mixing zone, the Cr for acute effects is compared to the Criterion Maximum Concentration, or CMC, which for WET is 0.3 TU_a. This CMC must be met at the edge of the acute mixing zone.

The larger circle is the chronic mixing zone where chronic sublethal WET test endpoints are considered as well as the lethal WET test endpoints. In this part of the receiving stream, the calculated Cr for chronic is compared to the Criterion Continuous Concentration, or CCC, which is the chronic WET criterion of 1.0 TU_c. This CCC must be met at the edge of the chronic mixing zone. So, at the edge of the acute mixing zone, the Cr, or the calculated acute WET value for the effluent concentration in the receiving stream, has to be less than or equal to the CMC, or 0.3 TU_a. At the edge of the chronic mixing

zone, the Cr, the calculated chronic WET value for the effluent concentration in the receiving stream, has to be less than or equal to the WET CCC, or 1.0 TU_c.

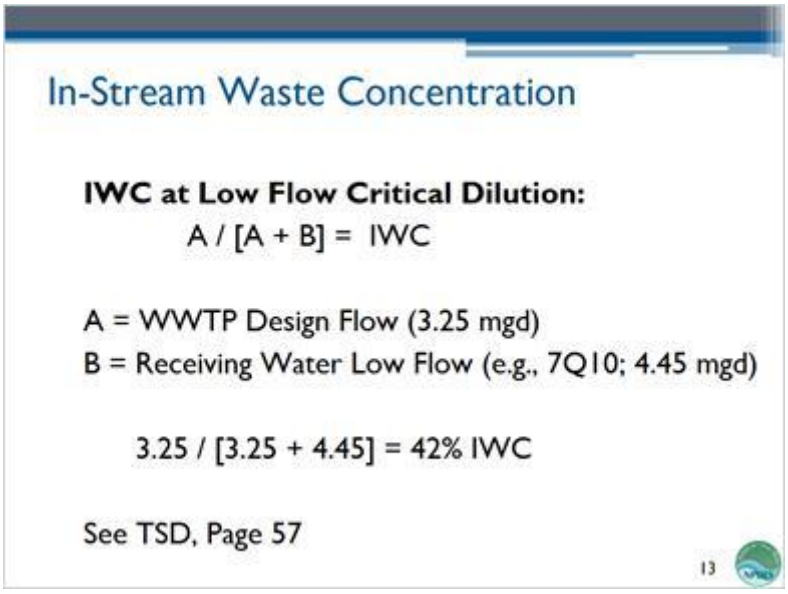
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

In calculating RP for WET, the maximum toxicity value observed, converted to toxic units, and the reasonable potential multiplying factor, or RPMF, are used to obtain the RP value. This calculation is performed separately for acute and chronic WET. The second bullet on this slide states that toxic units must be based on point estimate endpoints, such as the LC_{50} and IC_{25}, not hypothesis endpoints such as NOEC. The reason for this is that if you were to use a hypothesis endpoint you could get a CV of zero. More reliable estimates of the WET CV are obtained using point estimate endpoints. RP is calculated separately for each USEPA WET test species and WET test endpoint. USEPA's recommended RP analysis approach does not mix USEPA WET test species or WET test endpoints.

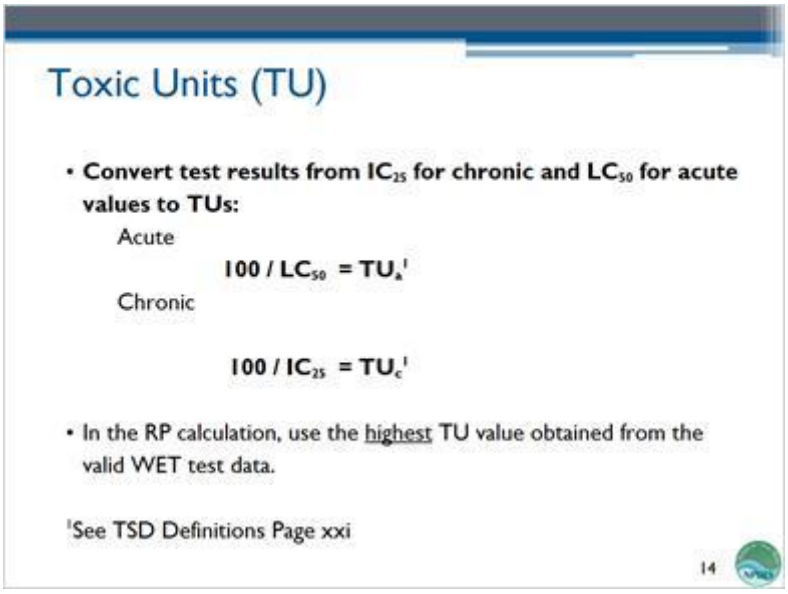
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

As discussed previously, one of the factors that could be considered in RP determinations is the available effluent dilution, which is expressed as the In-Stream Waste Concentration, or IWC, under the critical receiving waterbody condition. In the example on this slide and the following slides, it is assumed that a mixing zone is allowed in the state water quality standards and/or state permitting regulations. The facility design flow of the wastewater treatment plant in this example is 3.25 million gallons per day, or MGD. To calculate the IWC, the facility's design flow, the numerator, is divided by the sum of the critical receiving water low flow, which in this example is 4.45 million gallons per day, and the facility's design flow which in this example was 3.25 MGD, the denominator. This division in this example yields an IWC value of 0.42, or 42 percent. Thus, the IWC in this example is 42% effluent. The foregoing calculation is explained on page 57 of USEPA's TSD. Make note of this IWC of 42 percent because it will be used in later calculations in this module.

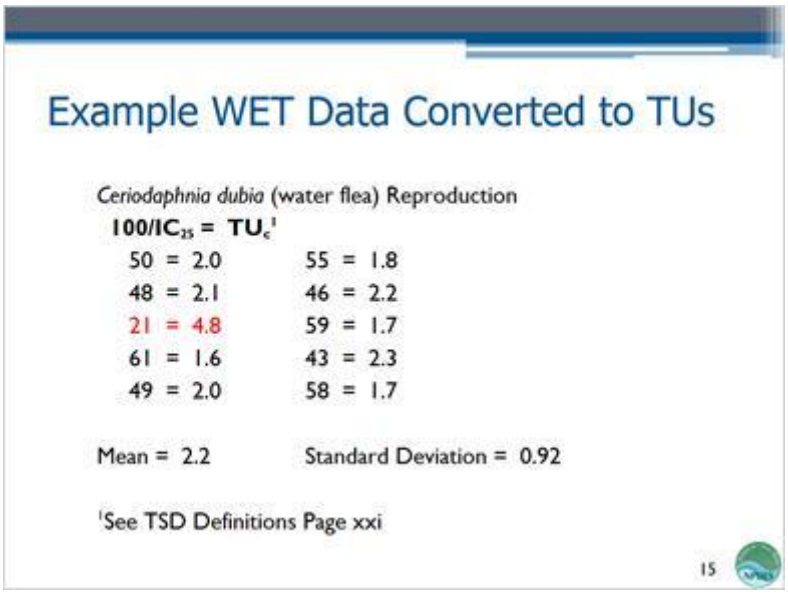
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

The next step is to convert the WET test results to toxic units, or TUs. TUs are used because it makes the math easier. For acute WET, we divide 100 by the LC_{50} to convert the LC_{50} to toxic units for acute. For chronic, we divide 100 by the IC_{25} to get toxic units chronic. Note that both the LC_{50} and the IC_{25} are point estimate endpoints, which are the preferred type of WET endpoint for RP analysis. In the RP calculation, we use the highest TU value observed from the valid WET test data generated.

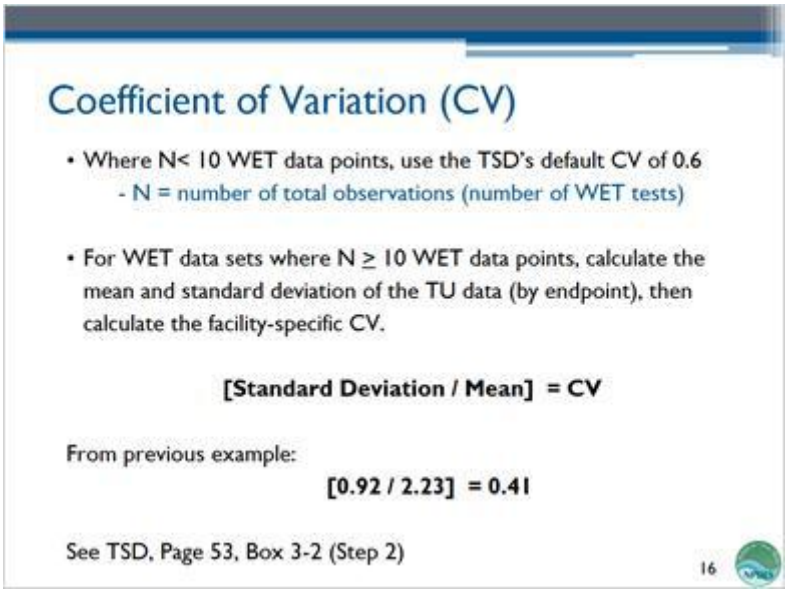
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

This slide presents example valid WET test results for a facility. The numbers on the left side of each equation are the IC_{25} values observed for each WET test. The numbers on the right side of each equation are the IC_{25}s expressed as TUs chronic, or TU_c. Thus, when there was an IC_{25} of 50, the chronic toxic units is equal to 2.0 TU_c. Note that the highest TU in this example is the TU_c of 4.8. This represents the most toxic sample tested in this example corresponding to the lowest (most toxic) IC_{25} value of 21% effluent. Note that the mean and standard deviation of the TU values are calculated. This will be discussed in the next slide.

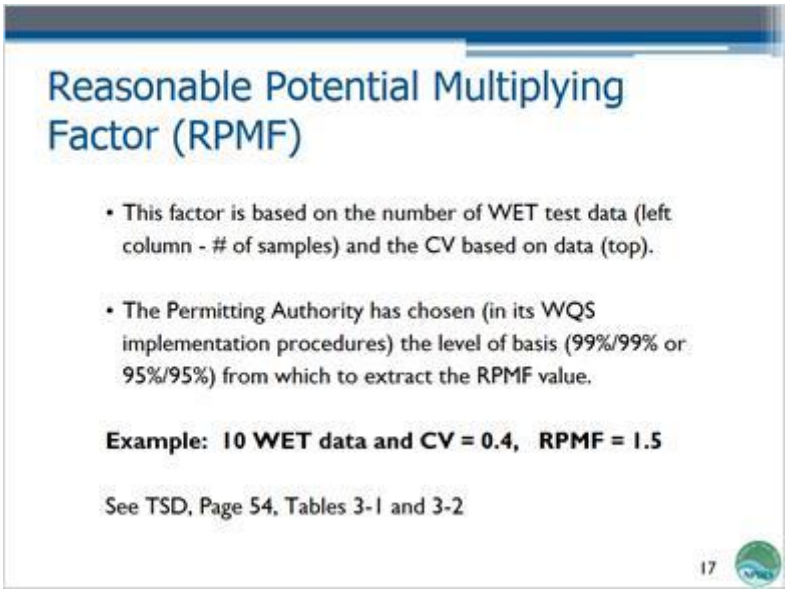
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

As mentioned previously in this module, if there are less than 10 WET test data points available, USEPA recommends using USEPA's TSD default Coefficient of Variation, or CV, value of 0.6. Where there are greater or equal to 10 WET test data points, the mean and standard deviation of the toxic unit values are calculated, and then the facility-specific CV is calculated. The standard deviation divided by the mean equals the CV. So using the information from the previous slide, the standard deviation of 0.92 is divided by the mean of 2.23, which yields a CV of 0.41. Note that this CV is lower than the default CV of 0.6, which will result in a lower RPMF using USEPA's TSD table, as we will see in the next slide.

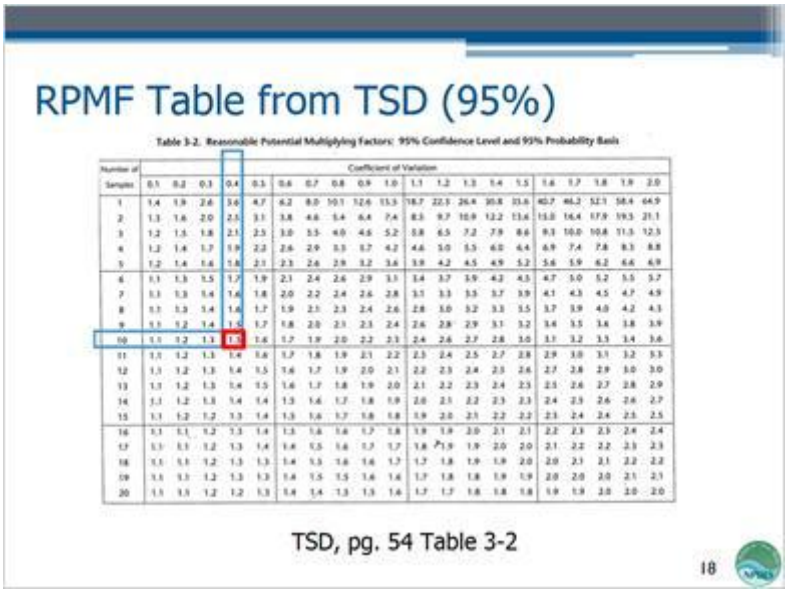
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

The RPMF is based on the number of WET test data points available, or "N," and the CV. Possible "N" values are listed in the first column of the RPMF table on pg. 54 of USEPA's TSD. Across the top row of this table are different CV values. Using the previous example, there are 10 valid WET test data points, so a facility-specific CV of 0.41 is used. Tables 3-1 and 3-2 in USEPA's TSD provides the RPMF values for different combinations of "N" using either the 99% or 95% probability basis, respectively. For this example, we are assuming the permitting authority uses the 95% probability basis for identifying RPMF values. Therefore, we rely on Table 3-2 which is reproduced in the next slide. According to Table 3-2, using N=10 and a CV of 0.41, the RPMF is 1.5. Note that if the default CV of 0.6 was used instead because of insufficient WET data, the RPMF value would have been higher at 1.7, according to Table 3-2, which would increase the probability of this facility having RP.

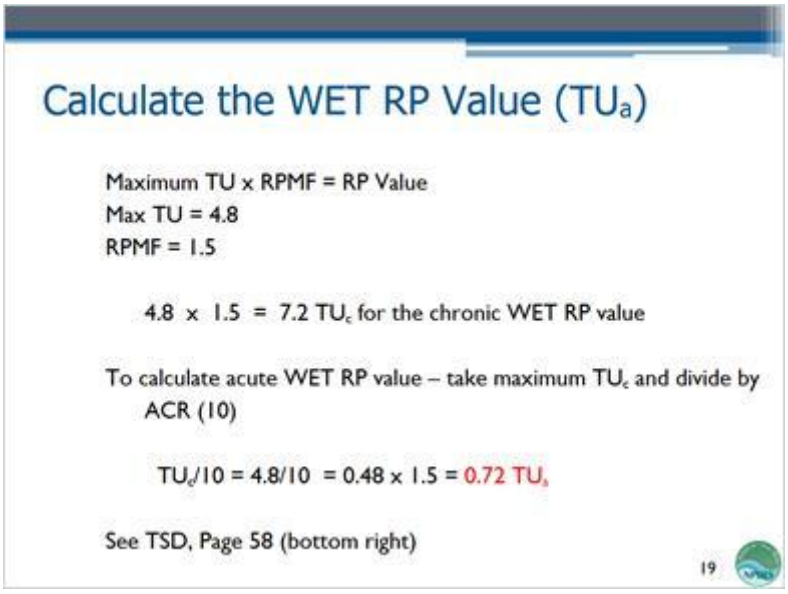
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

This is the RPMF Table 3-2 in USEPA's TSD on pg. 54, which again is based on a 95% probability basis. Starting with the left column, proceed to the corresponding row for the number of available WET test data, then going across the top of the table, find the corresponding CV closest to the calculated facility-specific CV (or the default CV of 0.6 where there are less than 10 valid WET test data points), and the intersection of these two rows is the RPMF. The RPMF of 1.5 in our example will be used in subsequent slides in the RP analysis.

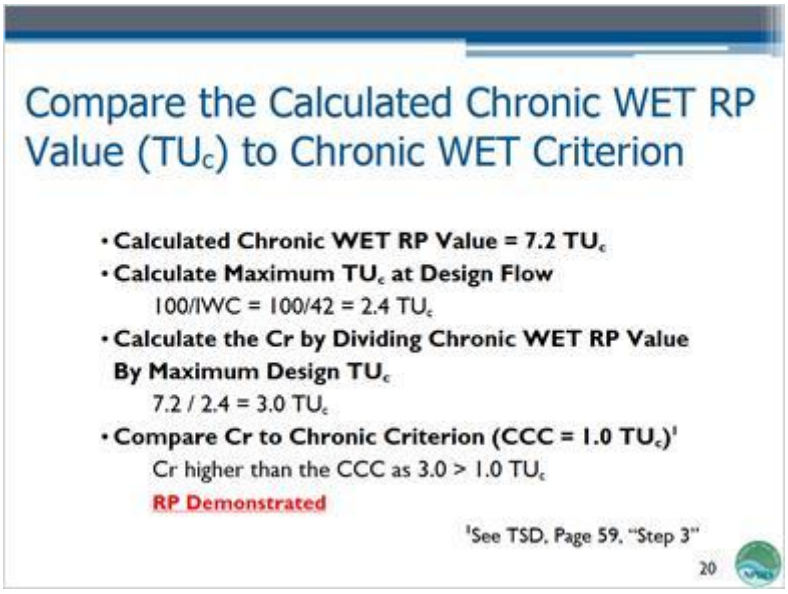
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

Back on slide 15, it was determined that the maximum TU_c observed based on the 10 valid chronic WET test data points was 4.8. This maximum toxicity value of 4.8 is multiplied by the RPMF of 1.5 that was just calculated in the previous slide. This yields a chronic RP value of 7.2 TU_c. To calculate the acute WET RP value based on valid chronic WET test data, divide the chronic RP value by the WET acute to chronic ratio, or ACR. Since a site-specific ACR is often not available, USEPA's TSD recommends a default WET ACR value of 10 for RP analyses. Therefore, taking the chronic RP value of 4.8 and dividing it by 10, yields 0.48 TU_a. Next, multiplying the acute TU_a of 0.48 by the RPMF of 1.5 equals 0.72. So, in this example, 7.2 TU_c is the chronic RP value, and 0.72 TU_a is the acute RP value.

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting

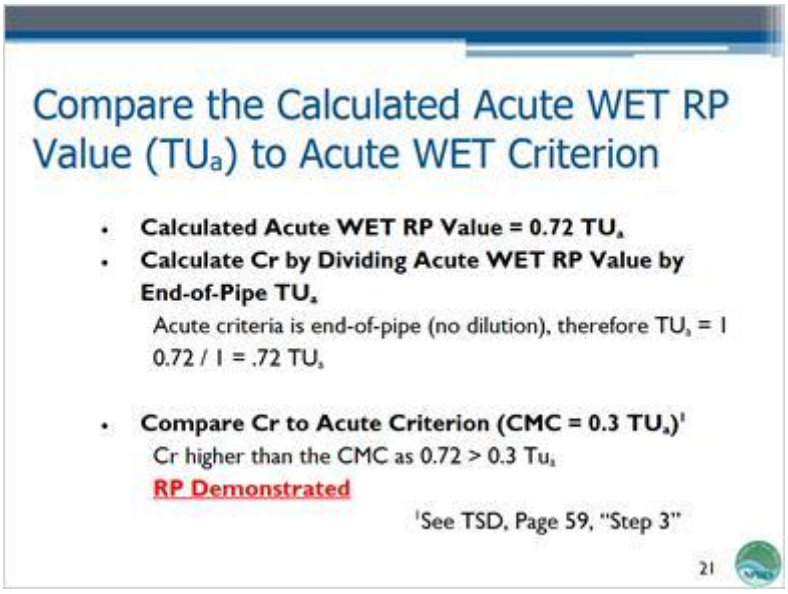


Notes:

Now for the final step in determining WET RP. The calculated acute and chronic RP values are compared to their respective WET criteria for aquatic life protection, after taking into account the effluent dilution, because in this example, a mixing zone was available.

First, we will calculate the WET RP chronic determination. To determine the maximum TU_c at design flow, divide 100 by the IWC of 42%, which yields a maximum TU_c of 2.4. Next, the chronic WET RP value of 7.2 obtained in the previous slide is divided by the maximum TU_c, which yields a value of 3.0 TU_c. When this value is compared to the USEPA recommended WET chronic criterion of 1.0 TU_c, 3.0 TU_c is greater than the chronic criterion of 1.0 TU_c, therefore, **RP has been demonstrated in this example**. **There is RP for chronic toxicity.**

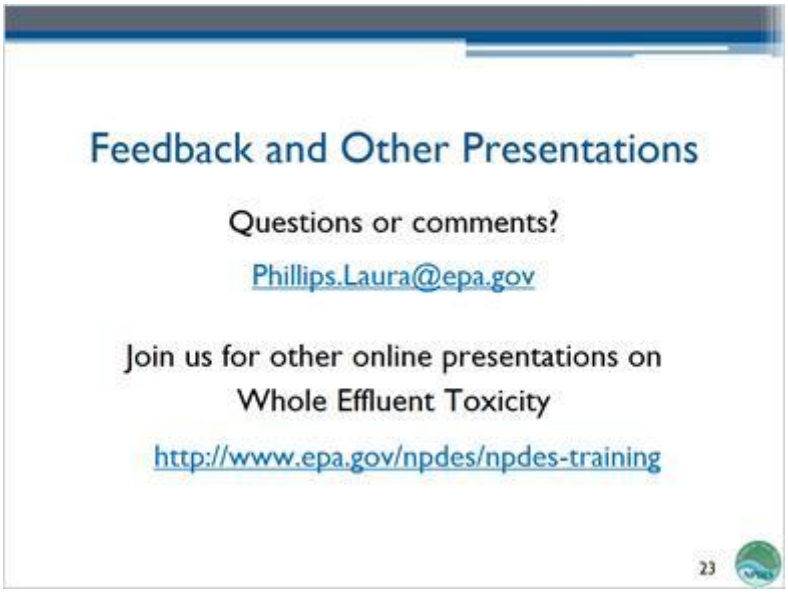
Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

Next, the acute WET RP determination is analyzed. On slide 19 it was determined that the maximum acute RP value is 0.72 TU_a. It was assumed that there is no mixing zone allowed under the state water quality standards. Therefore, the acute WET criterion must be met at the end of the facility's effluent discharge pipe, commonly referred to as the end-of-pipe, or 100% effluent. The maximum TU_a in this example, therefore, is 100 divided by 100% effluent which equals a TU_a value of 1. Next the acute RP value of 0.72 TU_a is divided by the TU_a value of 1, and therefore equals 0.72 TU_a. When this acute toxic unit RP value is compared to USEPA's recommended acute WET criterion for aquatic life protection of 0.3 TU_a, it is clear that the RP value is higher than the acute WET criterion of 0.3 TU_a. Therefore, **acute RP has been demonstrated in this example. There is RP for acute toxicity.**

Module 5: USEPA Determining WET Reasonable Potential for NPDES Permitting



Notes:

Thank you for joining us for this USEPA's NPDES Whole Effluent Toxicity training presentation. We hope that you have enjoyed it!

If you have questions or comments on this or any part of the USEPA's NPDES WET online training curriculum, click on the email address given on this slide to send a message to Laura Phillips, USEPA HQ National WET Coordinator.

Remember, you will find all of the USEPA's NPDES WET online training presentations, under the USEPA's NPDES training section found on the Office of Wastewater Management's NPDES website.

See you next time!