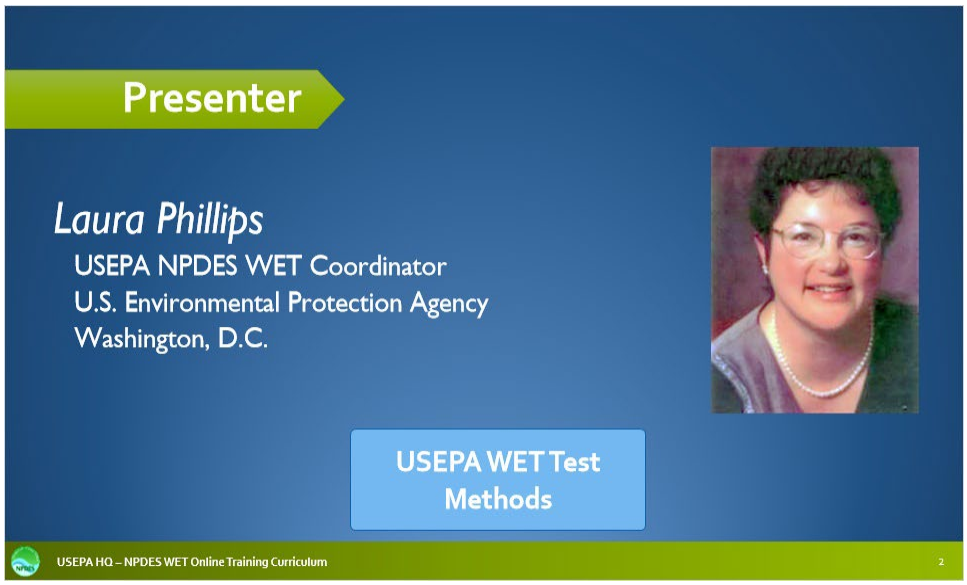
Module 8 - USEPA NPDES WET Permit Limit Development

Notes:

Welcome to this presentation on the United States Environmental Protection Agency's, hereafter USEPA, National Pollutant Discharge Elimination System, or NPDES, Whole Effluent Toxicity Permit Limit Development. This presentation is part of a web-based training series on Whole Effluent Toxicity, or WET, sponsored by the USEPA 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 the series, which cover the use of WET in USEPA's NPDES permit program.
Before we get started with this presentation, I have two important housekeeping items.



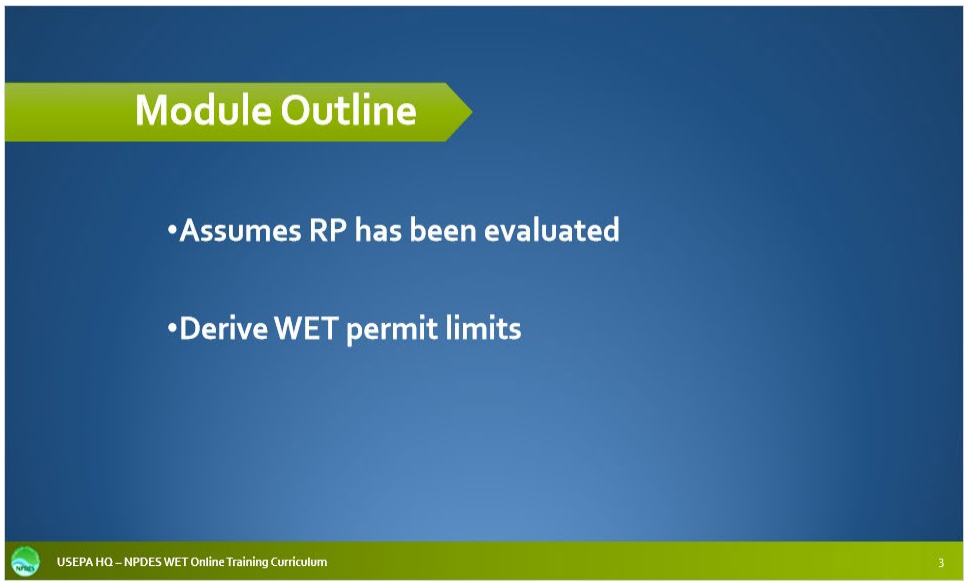
Notes:

First, let me introduce myself. My name is Laura Phillips, and I'm USEPA's NPDES WET Coordinator with the Water Permits Division within the Office of Wastewater Management at the USEPA Headquarters 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 USEPA. The NPDES permits program, which includes the use of WET 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 WET in the NPDES permit program. USEPA may revise and/or update the contents of this presentation in the future.

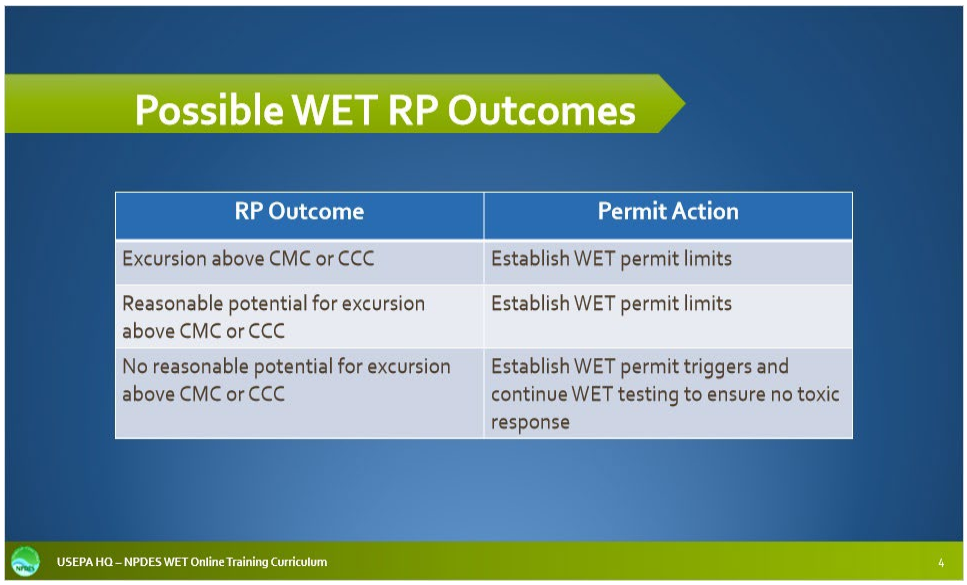
Also, this module was developed based on the live USEPA Headquarters' NPDES WET course that the Water Permits Division of the Office of Wastewater Management has been teaching to USEPA regions and states for several years. This course, where possible, has been developed with both the non-scientist and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

When appropriate a blue button will appear on a slide to provide access to more information. 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.
Let's take a look at the development of USEPA NPDES WET permit limits.



Notes:

For the purposes of this module, it is assumed that a reasonable potential, or RP, analysis has been conducted for the NPDES permitted discharger, and reasonable potential has been demonstrated. This module will focus on the process of deriving NPDES WET permit limits.



Notes:

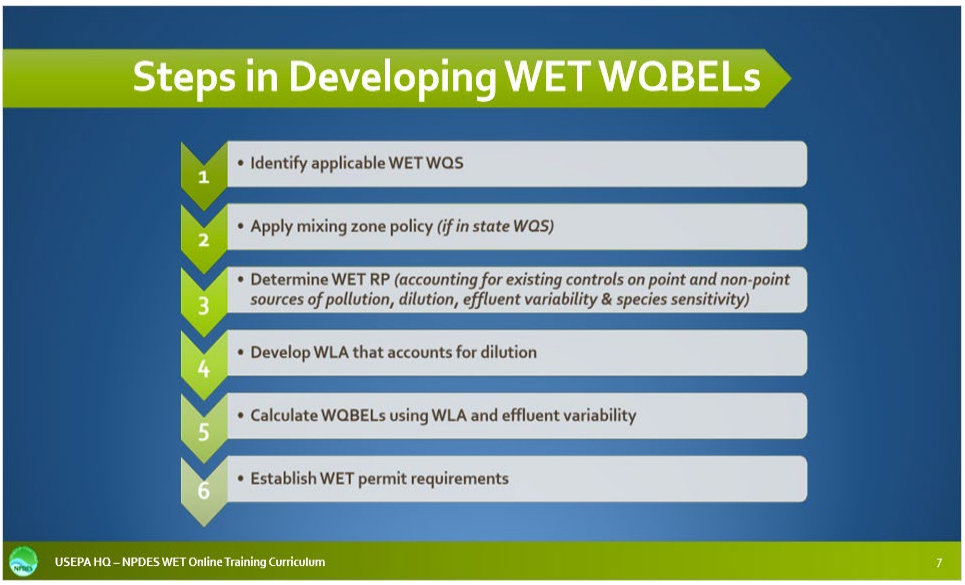
One outcome of an RP analysis is that there has been an excursion of either the narrative or numeric aquatic life protection criteria, commonly referred to as WET criteria, for acute or chronic toxicity, or for both. Another outcome is where an excursion has not occurred, but based on the RP analysis, the potential exists for an excursion or the potential to contribute to an excursion of a state's WET water quality standards. For these two RP outcomes, it is required under USEPA's NPDES permit regulations listed at Title 40 of the Code of Federal Regulations, or CFR, Part 122.44(d)(1)(iv) for numeric WET criteria and Part 122.44(d)(1)(v) for narrative WET criteria, to establish a NPDES WET limit. A third possible outcome of RP analysis is that there is no potential for an excursion above either the acute or chronic WET criterion. In this case, the permit action is to establish triggers and to continue monitoring to ensure that water quality standards are protected.

Notes:

To ensure the protection of state WET water quality standards, USEPA developed NPDES permit water quality-based procedures for developing water quality-based effluent limits, or WQBELs. These water quality-based procedures are the same for WET as they are for any other pollutant parameter. WET WQBELs are established to prevent acute and chronic toxicity impacts that would result in an excursion of the state's water quality standards, including sub-lethal effects, such as reduced reproduction or growth. The water quality-based procedures calculate the wasteload allocation for an effluent discharge that will not result in an excursion of state water quality standards. The wasteload allocation, or WLA, takes into account effluent dilution, if a mixing zone is allowed under a state's water quality standards or permitting regulations, and also effluent variability. Once the WQBELs and other NPDES permit requirements are established, the permittee is accountable for meeting all the NPDES permit requirements, including any permit conditions and limits. However, if the NPDES permit conditions or requirements are not clearly expressed in the permit, then the permittee may not fully address what was intended, and it may be harder to enforce all the permit requirements. For WET, this means clearly expressing monitoring conditions, triggers or limits, and other permit requirements to establish clear expectations for the permittee and ensure that the requirements are fully enforceable.

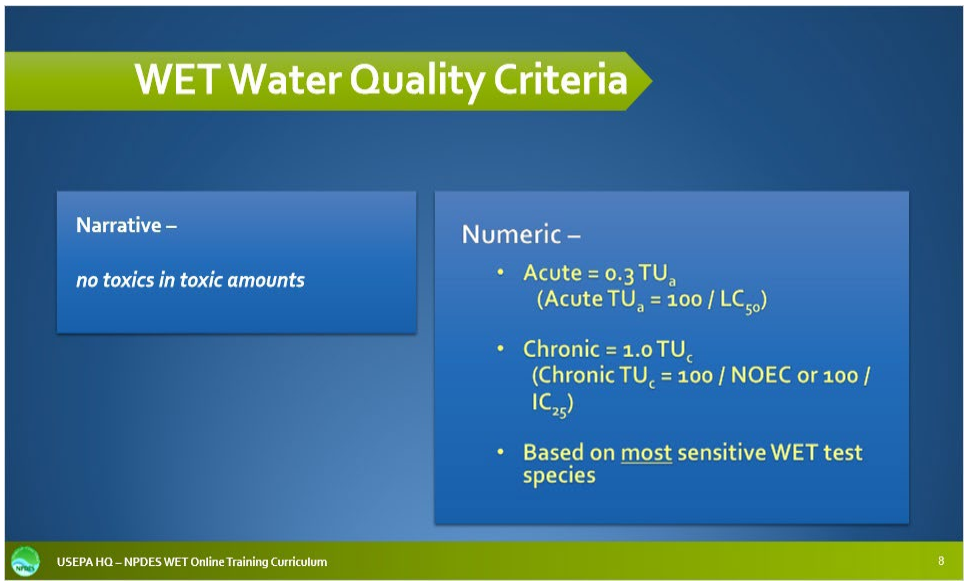
Notes:

As mentioned in the last slide, there is no substitute for a well-written NPDES permit. A well-written permit makes for fewer misunderstandings and miscommunications as to what the permittee is required to do in order to comply with their permit. See the WET Compliance and Enforcement module for more information on USEPA's enforcement program.



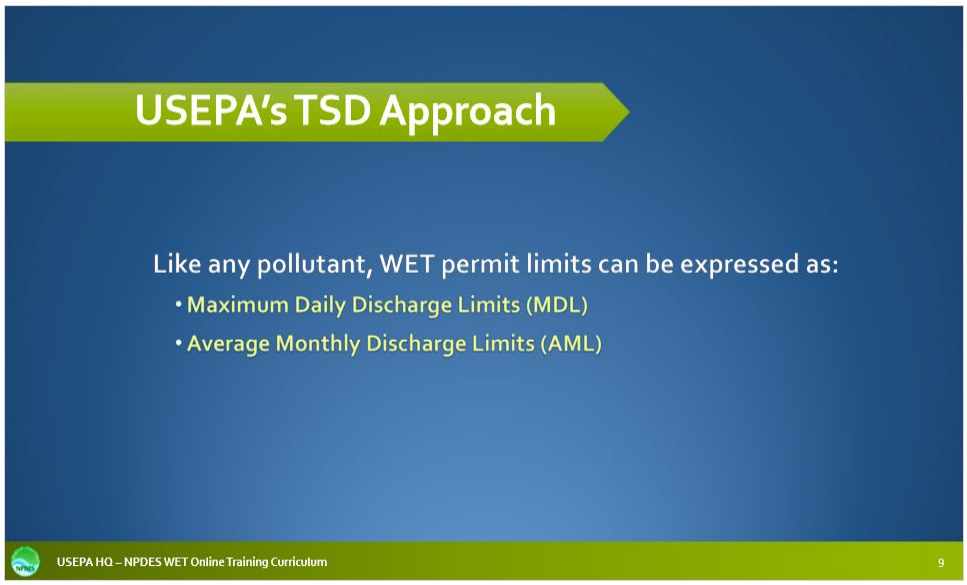
Notes:

There are several steps in developing NPDES WET WQBELs. These steps include: identifying the applicable water quality standards for WET; applying a mixing zone if allowed under the state's water quality standards or permitting regulations; determining RP by accounting for allowed effluent dilution, and characterizing effluent variability with respect to WET test results and the sensitivity of the test species. The WLA for the effluent is calculated and used, along with a determination of WET variability, to calculate WQBELs. Finally, this information is used to establish NPDES WET permit requirements including WET limits.



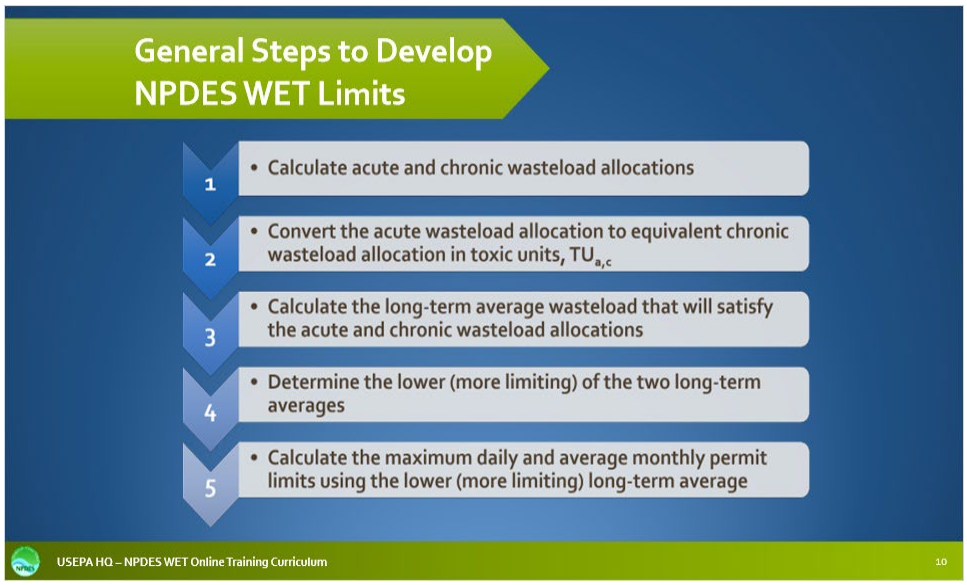
Notes:

WET water quality criteria are presented in the form of narrative and numeric criteria. Most states have a WET narrative criterion in their water quality standards similar to ”no toxics in toxic amounts.” WET testing directly addresses the narrative criterion. In addition to narrative criteria, some states have adopted the numeric acute and chronic WET criteria that are recommended in USEPA’s 1991 Technical Support Document for Water Quality-based Toxics Control, commonly referred to as the USEPA’s TSD. These numeric WET water quality criteria are 0.3 toxic units acute and 1.0 toxic units chronic. An acute toxic unit, or TU_a, is equal to 100 divided by the LC_{50}, and a chronic toxic unit, or TU_c, is equal to 100 divided by either the NOEC or IC_{25}. Compliance with WET triggers or limits based on these WET criteria is determined using valid WET data generated from WET tests using the most sensitive test species. The most sensitive test species is determined by conducting WET tests with ideally three test species, such as an alga, an invertebrate, and a vertebrate, with an effluent dilution series that brackets the in-stream waste concentration.



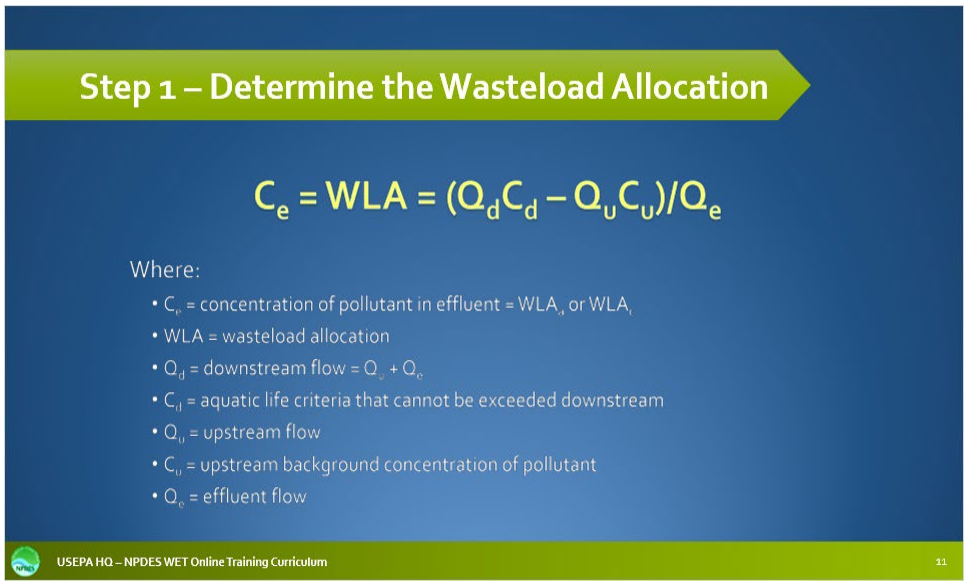
Notes:

In developing NPDES WET permit limits, WET is handled in the same way as other pollutant parameters. Both a maximum daily limit, or MDL, and an average monthly limit, or AML, are calculated for WET as explained in the following slides.



Notes:

To develop NPDES WET limits for a permitted effluent discharge, the first step is to calculate both the acute and chronic wasteload allocations and an “equivalent chronic wasteload allocation.” The equivalent chronic wasteload allocation is needed to calculate both an acute and a chronic long-term average, or LTA. The LTA concentration for WET is calculated such that it will satisfy both the acute and chronic WLAs. A determination is then made as to whether the acute or the chronic LTA is more limiting. The result of that determination is then used to calculate maximum daily and average monthly WET limits using the lower or more limiting

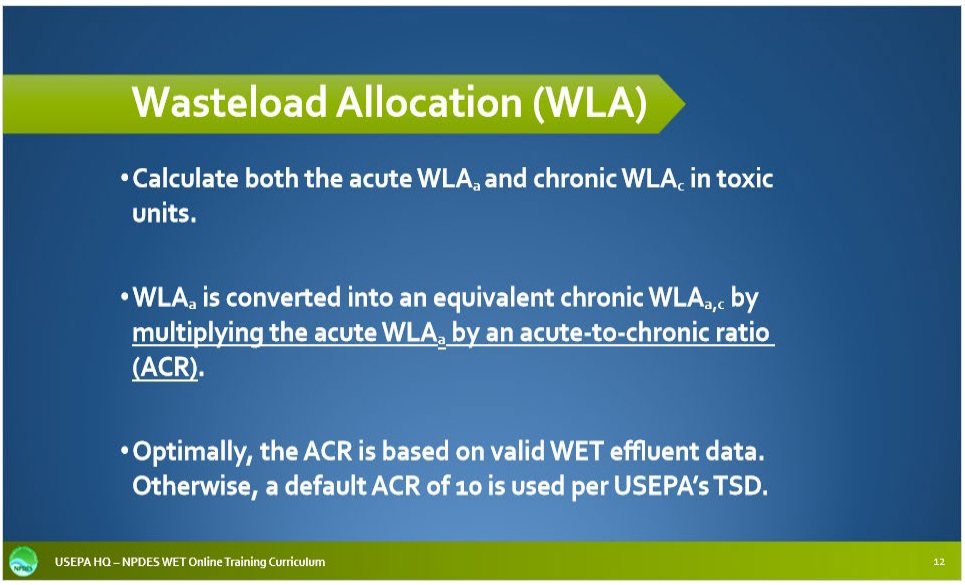


Notes:

In the first step, the WLA for WET is determined. Before starting, some key information will be required. First the receiving water upstream flow under critical conditions is identified, which is denoted as Q_u. Typically, the critical receiving water condition occurs under dry conditions when receiving water flow is at a relatively low level and is usually expressed as cubic feet per second, or cfs. Second, the permitted facility's effluent design flow (also expressed in cfs), denoted here as Q_e, needs to be determined. Third, the state's WET criteria to be met downstream, denoted here as C_d, needs to be identified. The downstream flow, denoted as Q_d, is determined by adding the upstream flow under critical conditions (Q_u) to the facility's design effluent flow (Q_e). The other information needed is the upstream background concentration, or C_u, to account for toxicity, if any, in the upstream receiving water unless it is established that there is no upstream toxicity. The toxicity assessment of the upstream receiving water can be determined through ambient toxicity testing using the most sensitive WET test species for both acute and chronic toxicity using USEPA WET test methods. Once this required information is determined, the WLA calculations can begin.

The WLA is equal to the multiplied product of the downstream flow (Q_d) and the downstream aquatic life protection criteria (C_d), from which is subtracted the multiplied product of the upstream flow (Q_u) and the background concentration (C_u). That calculated result is then divided by the facility's design effluent flow (Q_e). As mentioned before, when establishing in-stream WET permit limits the upstream background toxicity, or C_u, is factored into the WLA. If it is known that the upstream water is not toxic to the test species selected for evaluating the toxicity of the

effluent using USEPA WET test methods, then the C_u would equal zero, and the multiplied product or term Q_uC_u would also be zero in this equation.

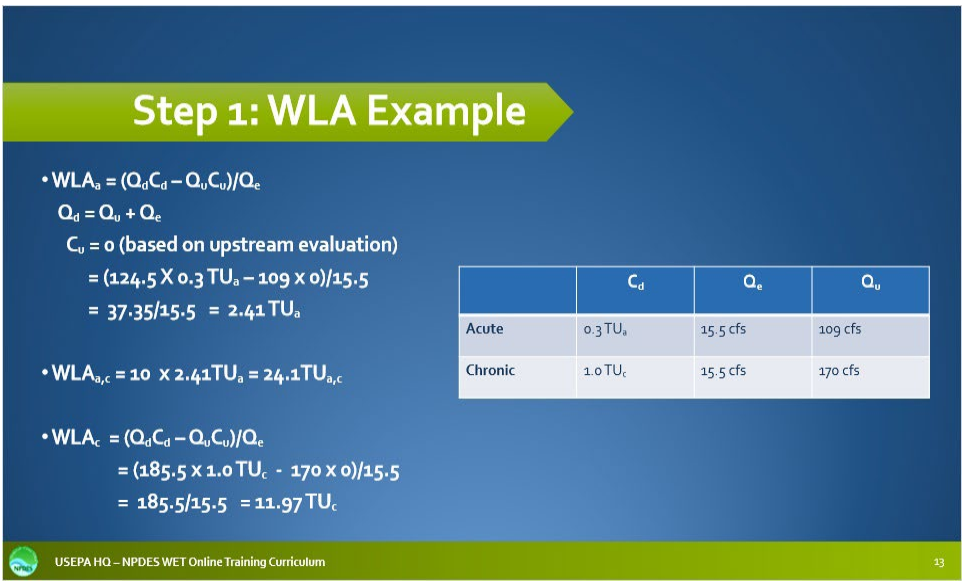


Notes:

When calculating the WLA used later to calculate both the acute and chronic LTA, it is necessary to consider both acute and chronic toxicity. The first step is to calculate the acute wasteload allocation, or $WLA_{a,}$ in acute toxic units, or TU_a.

The next step is to convert the WLA_a to what USEPA refers to as an "equivalent chronic waste load allocation or $WLA_{a,c}$" by multiplying the WLA_a by an acute-to-chronic ratio, or ACR. This conversion of the WLA_a is done so the acute toxicity effects can be compared to the chronic toxicity effects. The $WLA_{a,c}$ will be used later in the LTA calculations to determine which LTA is lower and, therefore, more conservative towards protecting the state's WET water quality standards. Ideally, the ACR would be based on the actual ratio of acute and chronic toxicity units from valid WET test data for the permitted effluent discharge. This site-specific ACR is rarely available, however, because of a lack of simultaneous acute and chronic WET test data. Therefore, the USEPA recommended default ACR of 10, provided in the USEPA's TSD, is typically used to obtain the equivalent chronic $WLA_{a,c}$.

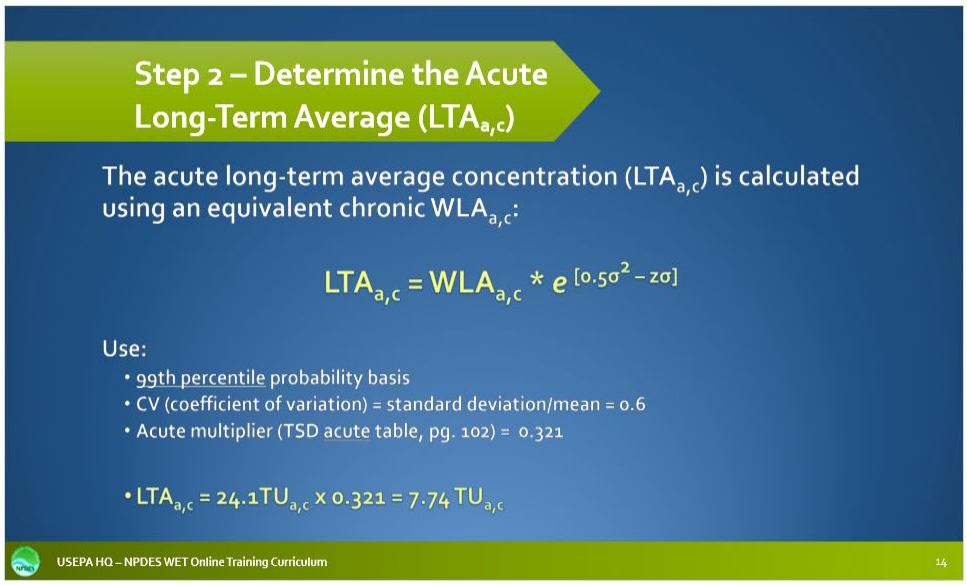
Finally, the last step before calculating the LTA is to calculate the chronic wasteload allocation or WLA_c in chronic toxic units, or TU_c.



Notes:

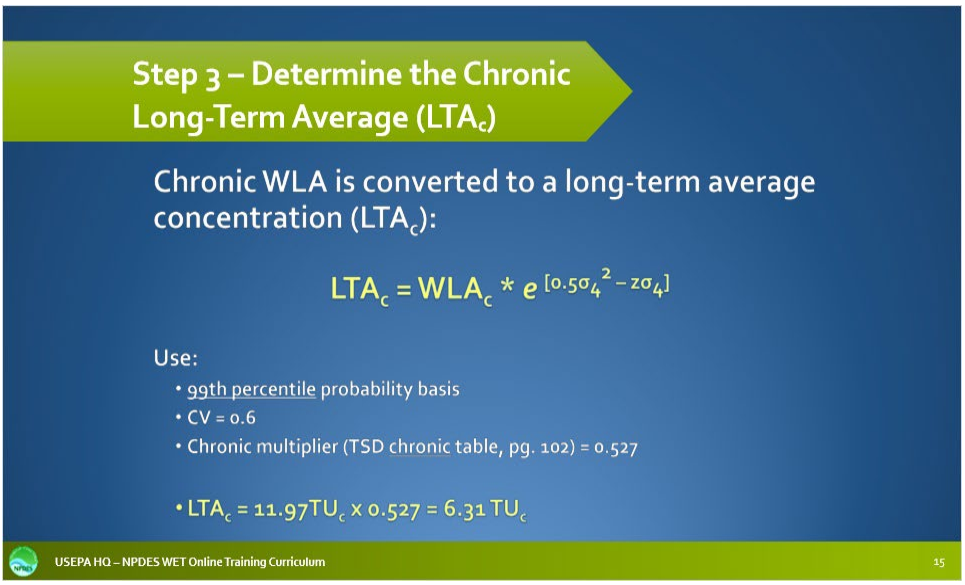
In this WLA calculation example, all the necessary information including the acute and chronic WET criteria (C_d) as well as the upstream and facility's effluent design flows are provided. For acute WET, the criterion is 0.3 TU_a, and for chronic WET, the criterion is 1.0 TU_c. The Q_e is the effluent flow, which in this example is 15.5 cfs. The Q_e, or the facility's effluent design flow, will be used for both acute and chronic toxicity. The Q_u, which is the upstream flow, again under critical conditions, is different for the acute and chronic WLA in this example. That is because the state identified a different mixing zone for acute than for chronic WET for the effluent discharge into the receiving stream. Since the acute upstream flow for the acute mixing zone is less than the chronic upstream flow for the chronic mixing zone, this indicates that the effluent has less dilution available for the acute WLA calculation. The wasteload allocation for acute, WLA_a, for the mixing zone is the formula shown in the previous slide, using the WET acute criterion of 0.3 TU_a. For this example, it is assumed that the upstream background concentration for toxicity, or C_u, is zero, meaning that there is no toxicity upstream. The downstream flow is the sum of the acute upstream flow of 109 cfs and the facility's effluent flow of 15.5 cfs, which is equal to 124.5 cfs. This downstream flow of 124.5 cfs is then multiplied by the acute criterion of 0.3 TU_a. Since the upstream background toxicity or C_u, for the purposes of this example, is assumed to be zero, then the product of Q_u multiplied by C_u in the numerator is also zero. So, what remains in this equation is 124.5 cfs multiplied by 0.3 TU_a which equals 37.35 cfs TU_a divided by the effluent flow of 15.5 cfs, and the cfs units in the numerator and denominator cancel out, leaving only the unit of

TU_a. Therefore, this calculation results in a WLA_a value of 2.41 TU_a.
The next step is to convert the WLA_a to an "equivalent chronic wasteload allocation, or $WLA_{a,c}$", by multiplying the WLA_a by an ACR. For this example, the USEPA TSD's recommended default ACR of 10 is used, yielding an equivalent chronic $WLA_{a,c}$ of 24.1 $TU_{a,c}$ which denotes that the $WLA_{a,c}$ is a converted value based on an ACR.
Next, the chronic WLA, or WLA_c, is calculated based on the chronic mixing zone using the same equation as shown in the previous slide with the chronic WET criterion of 1.0 TU_c. Also, the WLA_c uses the chronic upstream flow, which in this example is 170 cfs. Using the same basic WLA formula used to calculate the WLA_a, plugging in the calculated downstream flow, Q_d, of 185.5 cfs multiplied by the downstream chronic criteria, C_d, of 1.0 TU_c equals a product of 185.5 cfs TU_c, from which is then subtracted the product of the chronic upstream flow, Q_u, of 170 cfs and the assumed background concentration, C_u, of zero. This calculation yields a numerator of 185.5 cfs TU_c. Finally, when dividing 185.5 cfs TU_c by the effluent flow of 15.5 cfs, the cfs units in the numerator and denominator cancel out, leaving only the unit of TU_c. Therefore, this calculation results in a WLA_c value of 11.97 TU_c.
So, we now have a 24.1 $TU_{a,c}$ from converting the acute WLA_a to an *equivalent chronic* $WLA_{a,c}$ and we have a chronic WLA_c of 11.97 TU_c. These WLAs will now be used in the next slides to calculate the acute long-term average concentration, or $LTA_{a,c}$, and the chronic long-term average concentration or LTA_c.



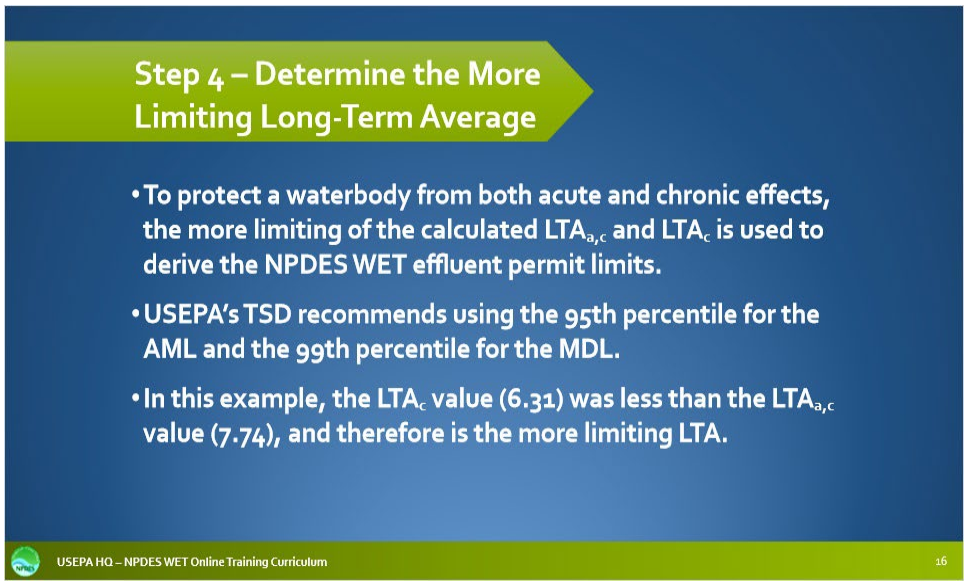
Notes:

Having calculated the wasteload allocation values, the next step is to determine the converted acute long-term average, or $LTA_{a,c}$, using the equivalent chronic $WLA_{a,c}$. Similar to the way the LTAs are calculated for other pollutant parameters, USEPA's TSD recommends using the 99th percentile probability basis for calculating the acute $LTA_{a,c}$. Page 102 of USEPA's TSD provides the tables that contain the multiplier term for the equation based on the coefficient of variation, or CV, of valid WET test data for the permitted facility. In this example, we use the default CV for WET of 0.6 because there was insufficient WET test data to calculate a facility site-specific CV. Using a CV of 0.6 and the 99th percentile probability basis, the table on page 102 of USEPA's TSD indicates that the acute multiplier is 0.321. Multiplying the converted $WLA_{a,c}$ of 24.1 $TU_{a,c}$ that was calculated in the previous slide by the USEPA's TSD multiplier of 0.321 results in an acute $LTA_{a,c}$ of 7.74 $TU_{a,c}$, indicating that this acute $LTA_{a,c}$ is an acute to chronic converted LTA. Since the acute $LTA_{a,c}$ has been converted to a chronic basis, this $LTA_{a,c}$ can now be directly compared with the chronic LTA_c, which we will calculate in the next slide.



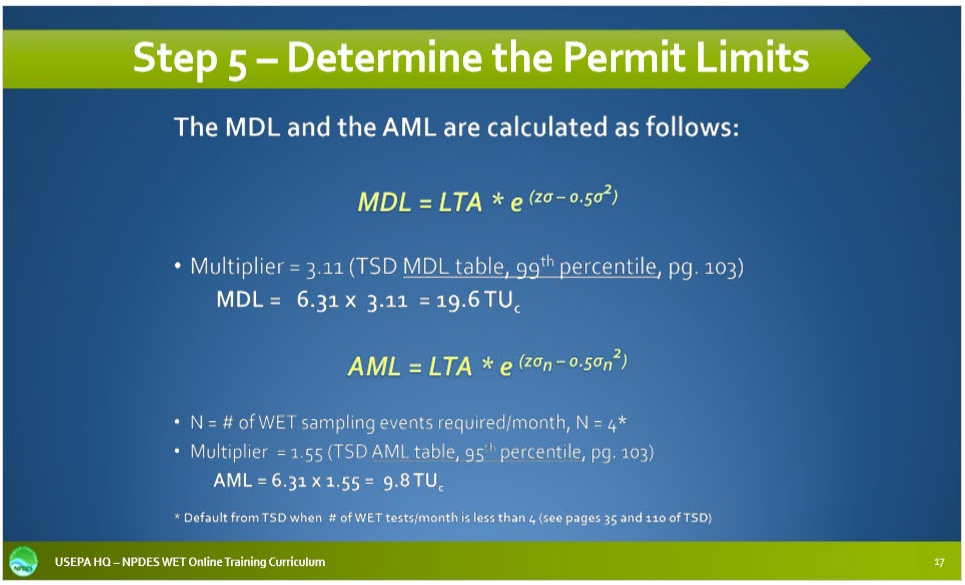
Notes:

To calculate the chronic LTA_c, we again use the 99th percentile probability basis. The CV is the same as before, the default value of 0.6. USEPA's TSD has another table on page 102 for the chronic LTA multipliers. Using the CV of 0.6, this table indicates a chronic multiplier of 0.527. Following the chronic LTA equation, the chronic WLA_c of 11.97 TU_c, calculated in the previous slide, is multiplied by the chronic multiplier of 0.527, which yields a chronic LTA_c of 6.31 TU_c.



Notes:

We need to determine which long-term average, the converted acute $LTA_{a,c}$ or the chronic LTA_c, is lower or more limiting. In this example, the LTA_c, or chronic long-term average, was 6.31 TU_c and the $LTA_{a,c}$, or the converted acute long-term average, was 7.74 $TU_{a,c}$. Therefore, the chronic long-term average of 6.31 TU_c was lower and is determined to be the more limiting LTA in this example.

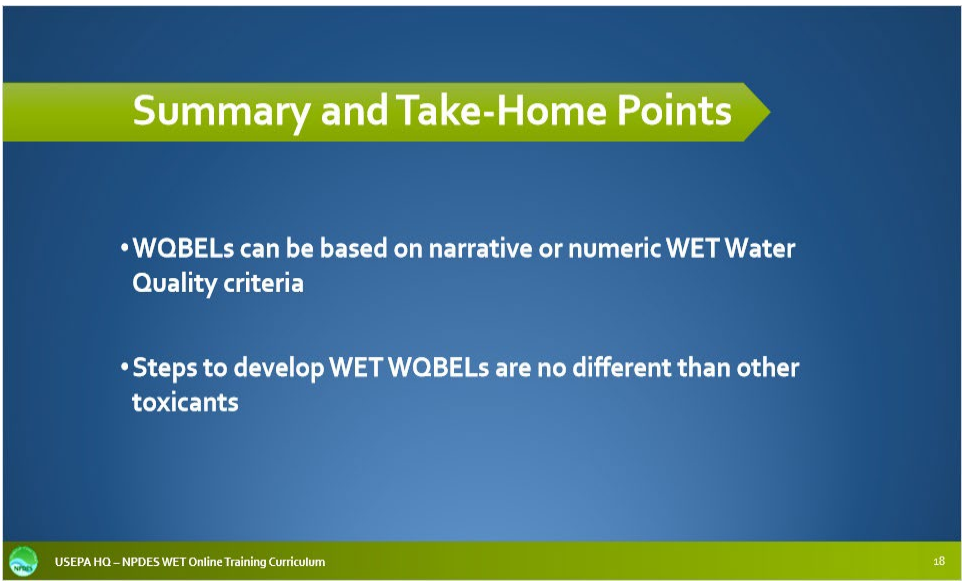


Notes:

To determine NPDES WET permit limits in Step 4, the more limiting or lower LTA is used. In our example this was determined to be the chronic LTA_c of 6.31 TU_c. The MDL and the AML are calculated using the formulas outlined in USEPA's TSD. The USEPA's TSD recommends using the 99th percentile for calculating the MDL and the 95th percentile for calculating the AML.

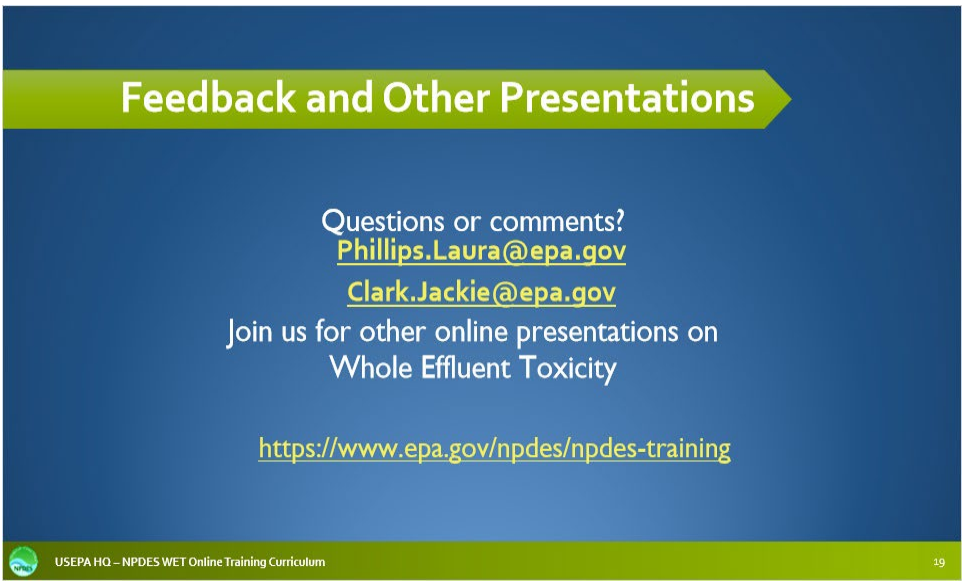
For the MDL, the chronic LTA_c is multiplied by a factor which can be found in USEPA's TSD using the 99th percentile table at the CV of 0.6 on page 103. Therefore, the multiplier provided at the intersection of the column for the 99th percentile and a CV of 0.6 is 3.11, which when multiplied by the LTA_c of 6.31 TU_c yields a MDL of 19.6 TU_c.

To calculate the AML, the more limiting LTA_c is multiplied by a factor which is found using the 95th percentile table on page 103 of USEPA's TSD. This multiplier factor relies on the number of WET sampling events required per month, or "N." USEPA's TSD recommends an "N" value of 4 when there are fewer than four WET test sampling events per month. The multiplier factor listed in the 95th percentile table at the intersection of the CV of 0.6 and an N=4 is 1.55. Therefore, the AML is the chronic LTA_c of 6.31TU_c multiplied by 1.55 which is equal to 9.8 TU_c.



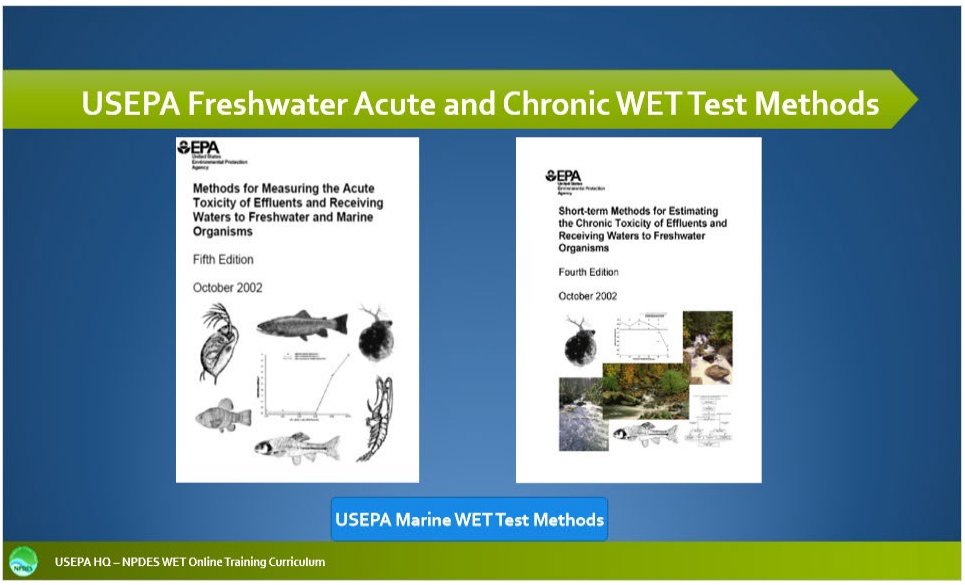
Notes:

In conclusion, some of the points that we hope you have learned in this module were that NPDES WQBELs can be based on either narrative or numeric WET water quality criteria. States with a narrative WET water quality criterion of "no toxics in toxic amounts" or those with numeric WET water quality criteria of 0.3 toxic units acute and 1.0 toxic units chronic, can develop WQBELs for WET in NPDES permits using the same process. This process for WET WQBEL development is handled in the same way as other pollutant parameters. As noted in this module the steps are outlined in USEPA's 1991 Technical Support Document for Water Quality-based Toxics Control.



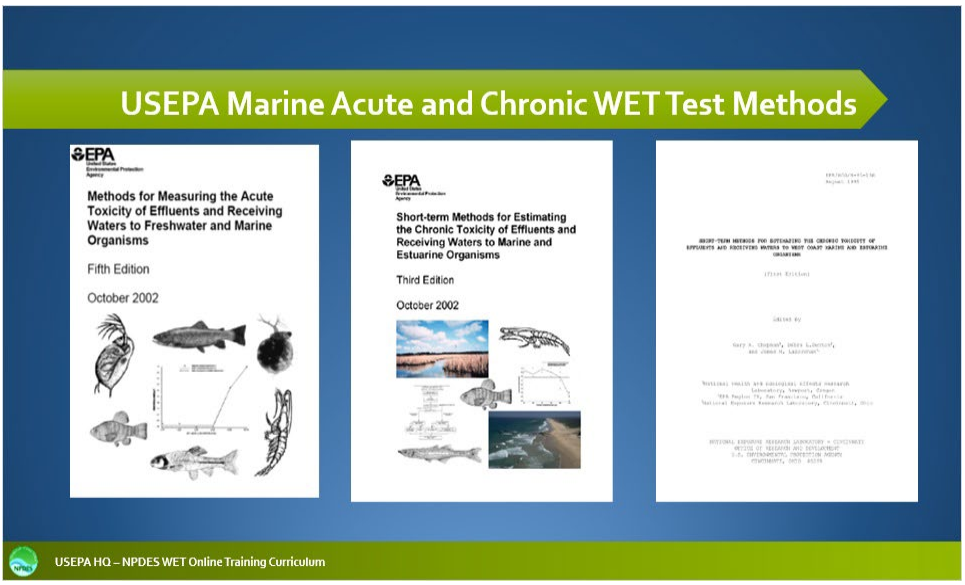
Notes:

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 any 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 or Jackie Clark, USEPA HQ NPDES WET Coordinators.
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!



Notes:

The base module presented here examines USEPA's freshwater acute WET test methods entitled "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", Fifth Edition, EPA-821-R-02-012, hereafter acute toxicity test methods. In addition, this module provides USEPA's short-term chronic freshwater WET test methods entitled "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms", Fourth Edition, EPA-821-R-02-013, hereafter chronic toxicity test methods.



Notes:

This course also provides an opportunity to view USEPA's acute marine WET test methods entitled "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms," Fifth Edition, EPA-821-R-02-012; short-term chronic marine WET test methods used by states on the Atlantic Ocean or Gulf of Mexico entitled "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms," Third Edition, EPA-821-R-02-014, hereafter East Coast test methods; or short-term chronic marine WET test methods used by states on the Pacific Ocean entitled "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms," First Edition, EPA-600-R-95-136, hereafter West Coast test methods.