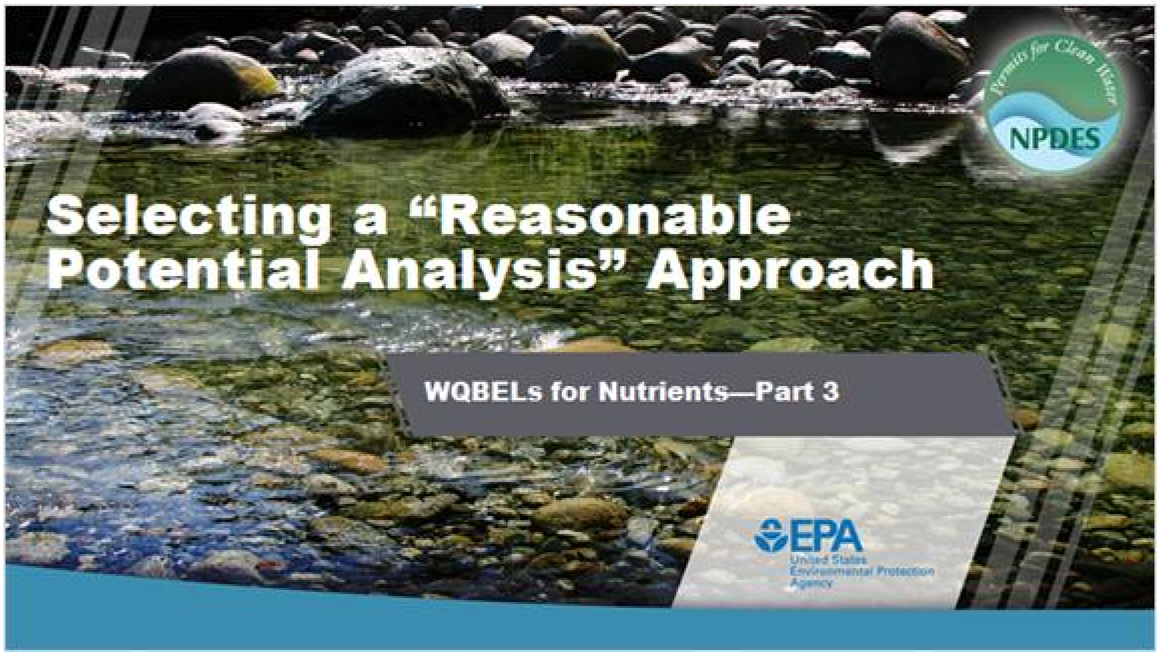
Selecting a "Reasonable Potential Analysis" Approach

1. Part 3: WQBELs for Nutrients-Part 3

1.1 Selecting a "Reasonable Potential Analysis" Approach



Notes:

Welcome to this presentation on water quality-based effluent limitations for nutrients in National Pollutant Discharge Elimination System, or NPDES, permits.

This presentation is part three of a six part section of the training on establishing water quality-based effluent limitations, or WQBELs, for nutrients. This training is sponsored by the United States Environmental Protection Agency's Water Permits Division.

In this presentation, we will consider selection of an approach to conducting a "reasonable potential analysis" for the purpose of determining whether water quality-based effluent limitations for nutrients are needed. Before we get started with this presentation, let's introduce our speakers, take care of a housekeeping item, and review where we are within the training series.

1.2 Presenters

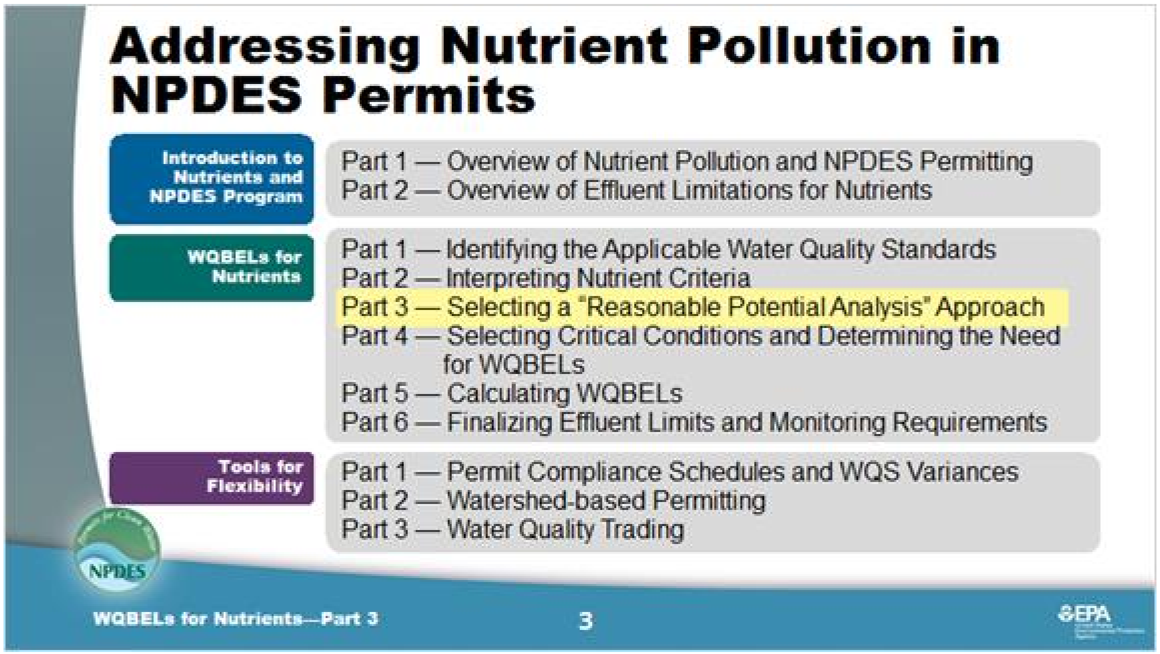
Notes:

Your speakers for this presentation are Nizanna Bathersfield and me, Danielle Stephan. We both are with the Water Permits Division of the United States Environmental Protection Agency in Washington, DC.

Now for our housekeeping item. I need to let you know that the materials used in this presentation have been reviewed by USEPA staff for technical accuracy; however, the views of the speakers are their own and do not necessarily reflect those of USEPA. NPDES permitting is governed by the existing requirements of the Clean Water Act and USEPA's NPDES implementing regulations. These statutory and regulatory provisions contain legally binding requirements. The information in this presentation is not binding. Furthermore, it supplements, and does not modify, existing USEPA policy, guidance, and training on NPDES permitting. USEPA may change the contents of this presentation in the future.

Let's take a look at where we are in the overall training series.

1.3 Addressing Nutrient Pollution in NPDES Permits



Notes:

This is part three of the section of our training on water quality-based effluent limitations for nutrients.

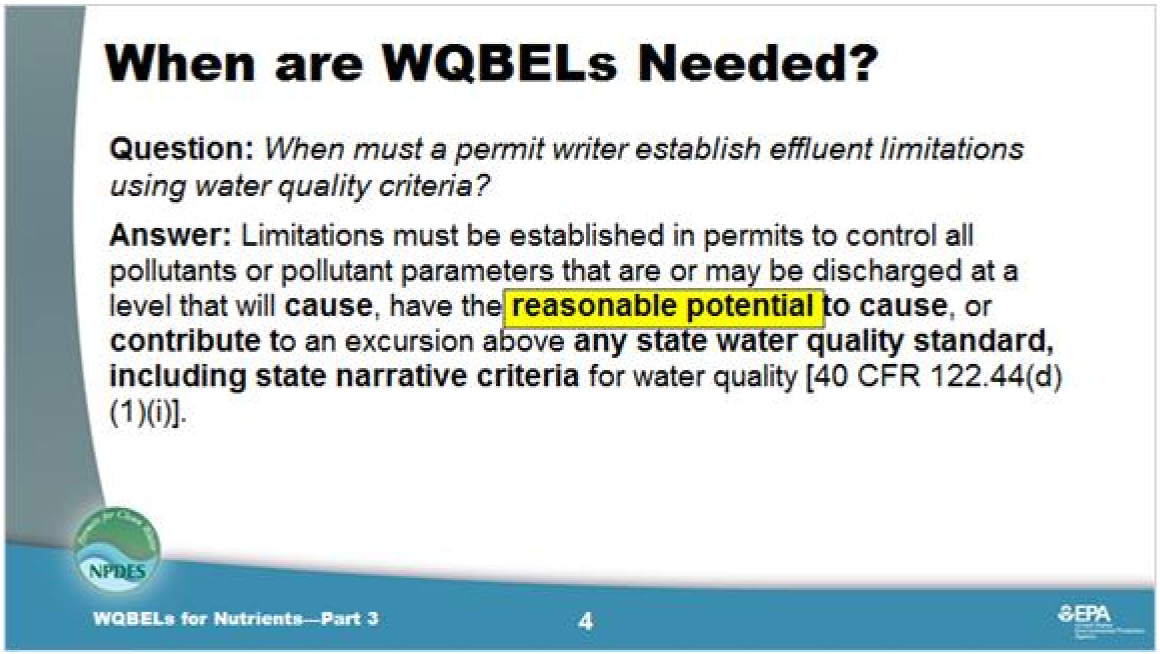
In parts one and two, we looked at how we identify the applicable water quality standards and interpret nutrient criteria in those standards in order to use them for NPDES permitting.

Now we will begin looking at the process for applying water quality standards to determine the need for and, where necessary, calculate water quality-based effluent limitations for nutrients.

Specifically, this presentation focuses on selecting an approach to determining the need for water quality-based effluent limits-a process called the "reasonable potential analysis." Let's take a look at where we get the name "reasonable potential analysis."

Can you help us out with that Nizanna?

1.4 When are WQBELs Needed?



Notes:

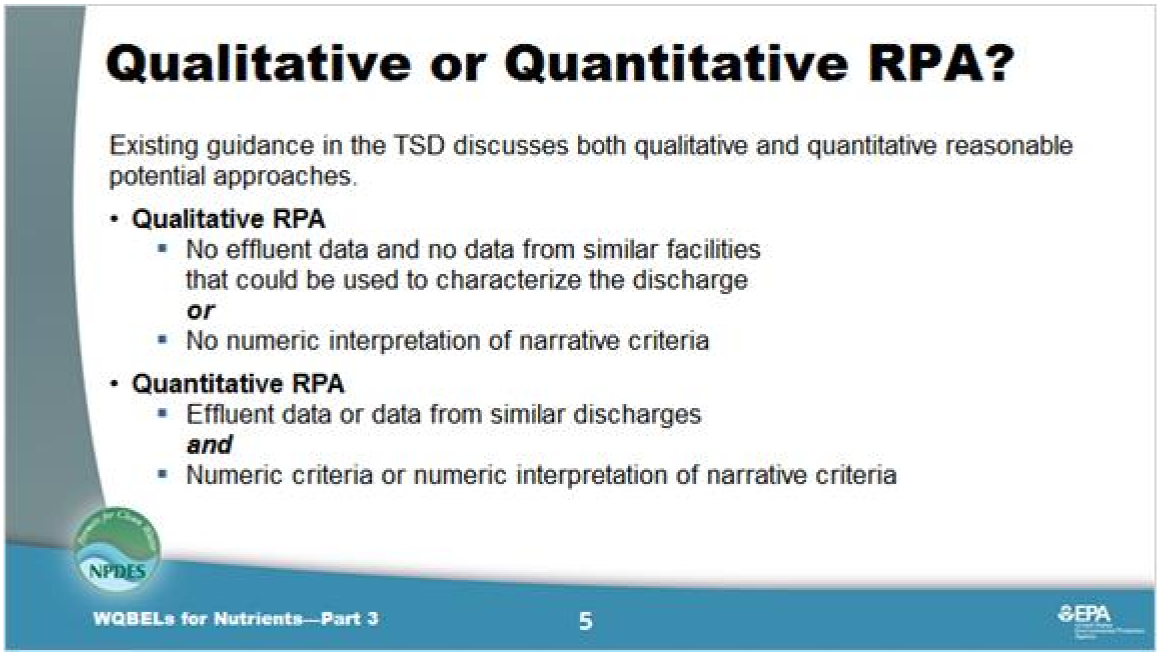
Sure, Danielle.

The regulations at 40 CFR 122.44(d)(1)(i) state: "Limitations must be established in permits to control all pollutants or pollutant parameters that are or may be discharged at a level that will ***cause***, have the ***reasonable potential to cause***, or ***contribute*** to an excursion above any state water quality standard."

Because of this regulation EPA, and many authorized states, refer to the process that a permit writer would use to determine whether water quality-based effluent limits are needed as the "reasonable potential analysis."

Let's consider two basic approaches to conducting a reasonable potential analysis.

1.5 Qualitative or Quantitative RPA?

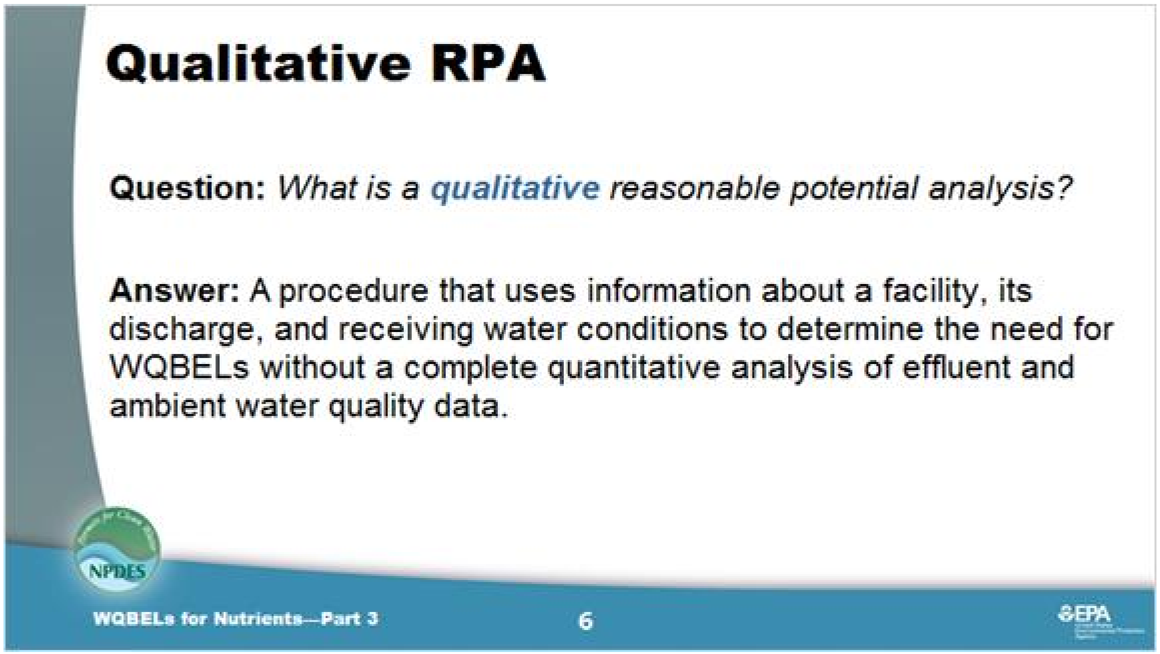


Notes:

We can conduct a reasonable potential analysis based on numeric or narrative criteria and, for each of these types of criteria, we can complete that analysis with or without effluent data. In fact, the NPDES regulations state that we need to consider both types of criteria in our analysis. In addition, existing EPA guidance addresses both qualitative and quantitative analyses.

In general, we would conduct a qualitative reasonable potential analysis in cases where we are missing effluent data (or data from similar facilities that could be used to characterize the discharge) or where we have no numeric interpretation of narrative criteria. On the other hand, if we have both effluent data and numeric criteria or a numeric interpretation of narrative criteria, a quantitative reasonable potential analysis is possible.

1.6 Qualitative RPA

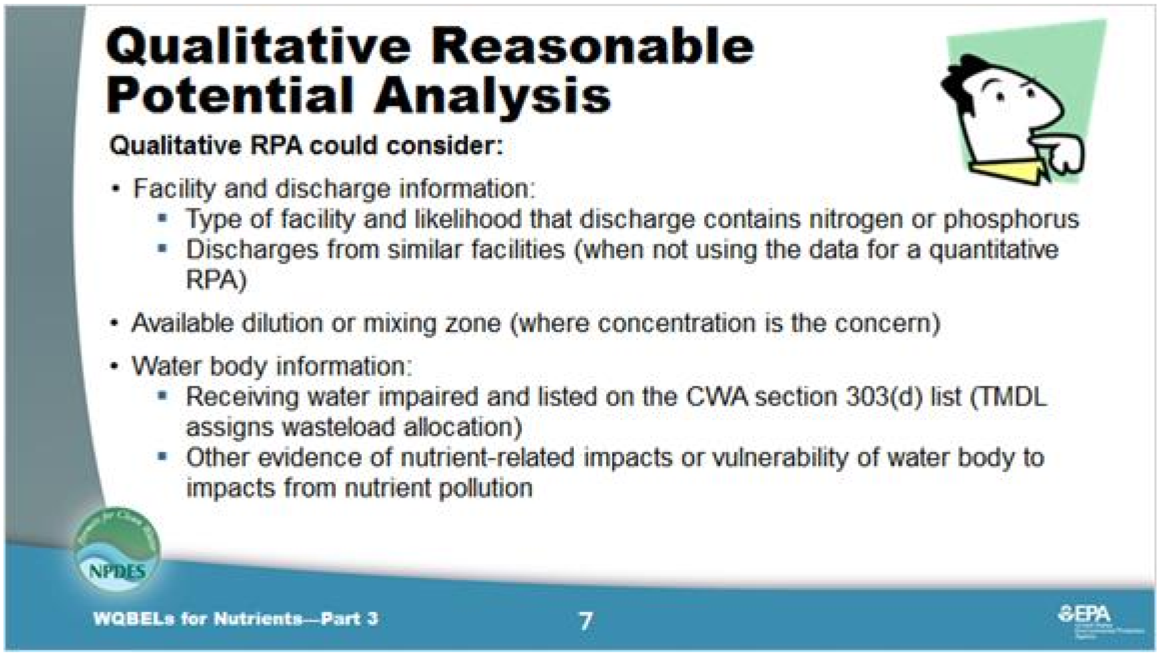


Notes:

What do we mean when we say "qualitative reasonable potential analysis"?

We mean that we are determining the need for water quality-based effluent limitations using a procedure that considers information about a facility, its discharge, and receiving water conditions, but without a complete quantitative analysis of effluent and ambient water quality data.

1.7 Qualitative Reasonable Potential Analysis



Notes:

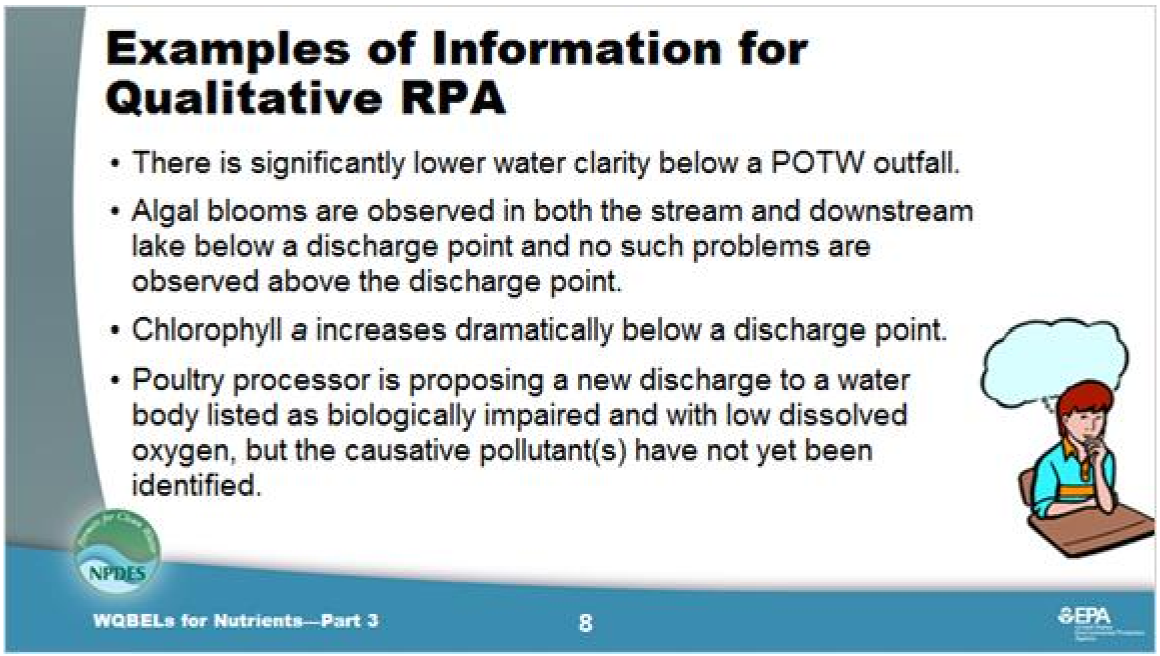
When we decide to undertake a qualitative reasonable potential analysis, we may consider:

- The type of facility and the likelihood that the discharge contains phosphorus or nitrogen.
- Discharges from similar facilities when we have decided not to use those data for a quantitative reasonable potential analysis for the facility we are permitting.
- The amount of dilution or size of the mixing zone that is available when nutrient concentrations in the receiving water are the concern.
- Inclusion of the receiving water on the Clean Water Act section 303(d) list.
- A total maximum daily load, or TMDL, that has assigned a wasteload allocation to the point source we are permitting. The NPDES regulations require that permit limits be consistent with the assumptions and requirements of an applicable wasteload allocation from the TMDL. Therefore, unless the assumptions are proved to be no longer valid, we would determine the facility has "reasonable potential" based on the TMDL.

- And, finally, other evidence of impacts or vulnerability of the water body to impacts from nutrient pollution using factors such as light availability, residence time, and temperature.

Section 3.2 of EPA's *Technical Support Document for Water Quality-based Toxics Control*, or TSD for short, provides further discussion of considerations for a permit writer in conducting a qualitative reasonable potential analysis.

1.8 Examples of Information for Qualitative RPA



Notes:

Here are some examples of information that could be used for a qualitative reasonable potential analysis for nutrients.

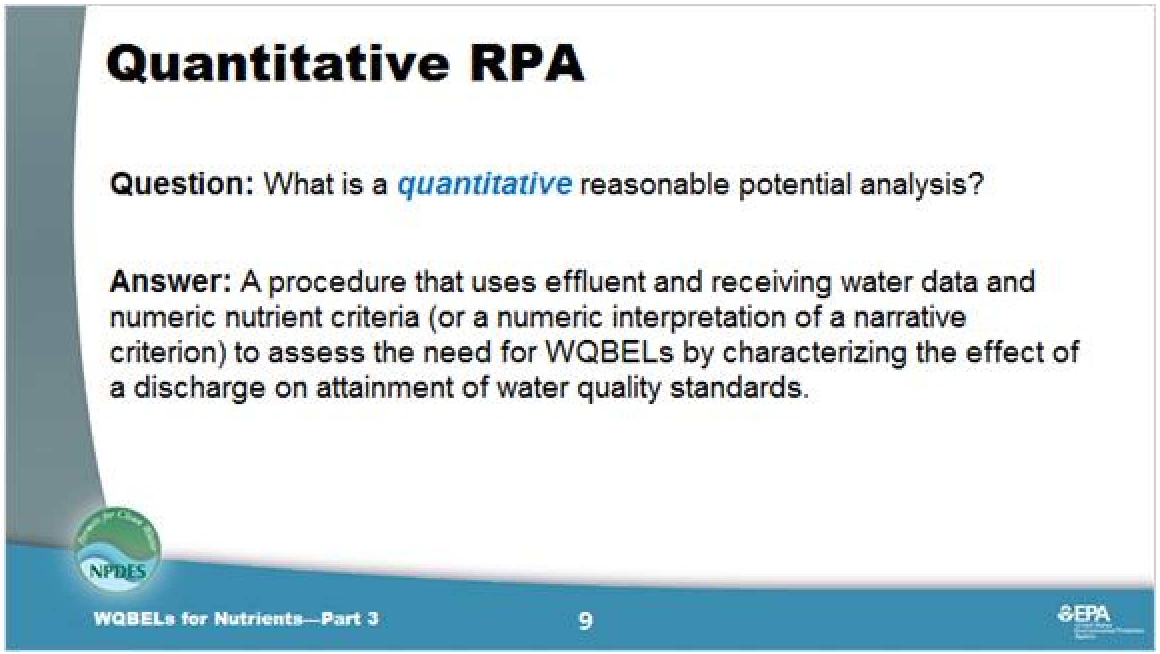
- Secchi depth drops significantly below a POTW outfall
- Algal blooms are observed in the flowing stream and downstream lake below a discharge point, but there are no such problems observed above the discharge point
- Chlorophyll *a* increases dramatically below a discharge point

- A poultry processor, which will discharge nutrients, proposes a new discharge to a water body listed as biologically impaired, but with no causative pollutant yet identified.

If we conduct a qualitative reasonable potential analysis, we would also want to consider effluent and, possibly, ambient monitoring requirements in the permit in order to collect the data needed for a future quantitative reasonable potential analysis.

Keep in mind as well that if our qualitative reasonable potential analysis is based on meeting a narrative criterion for which we have not developed a numeric interpretation and if we decide that effluent limits on nutrients are needed, at some point we would have to interpret the narrative criterion in order to calculate water quality-based effluent limits for nitrogen or phosphorus or both. A detailed discussion of interpreting narrative criteria for nutrients is presented in Part 2 of this section of the training.

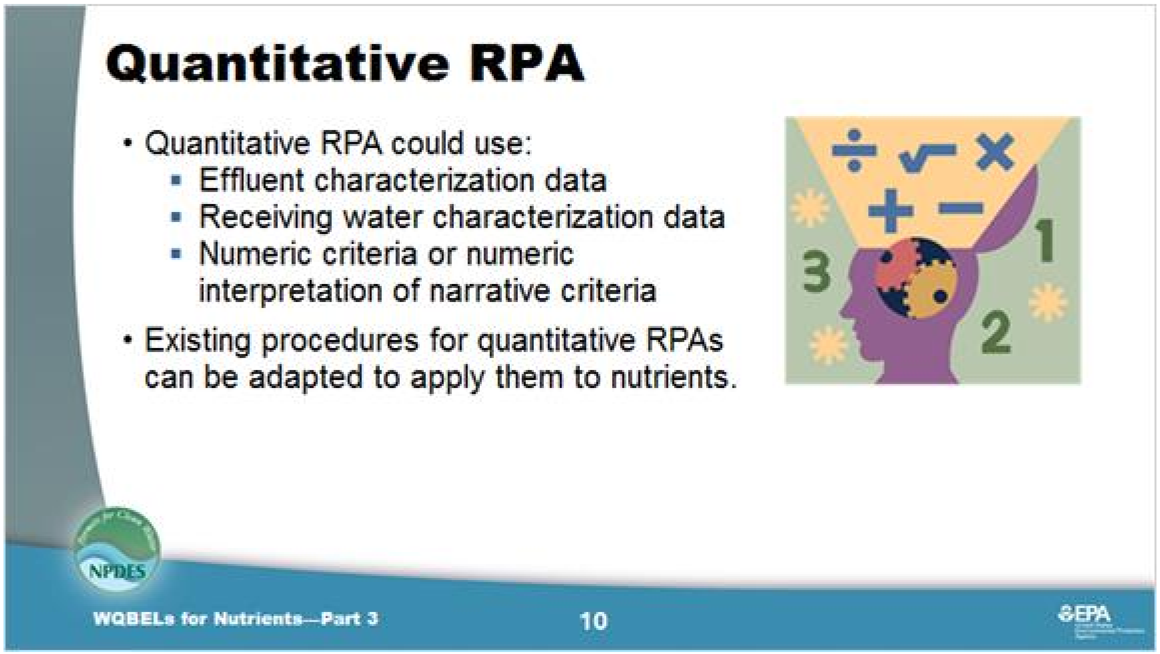
1.9 Quantitative RPA



Notes:

Now let's discuss what we mean when we say quantitative reasonable potential analysis. We mean that we are using a procedure to determine the need for a water quality-based effluent limitation based on an analysis of effluent and receiving water data that predicts the effect of the discharge on attainment of water quality standards.

1.10 Quantitative RPA

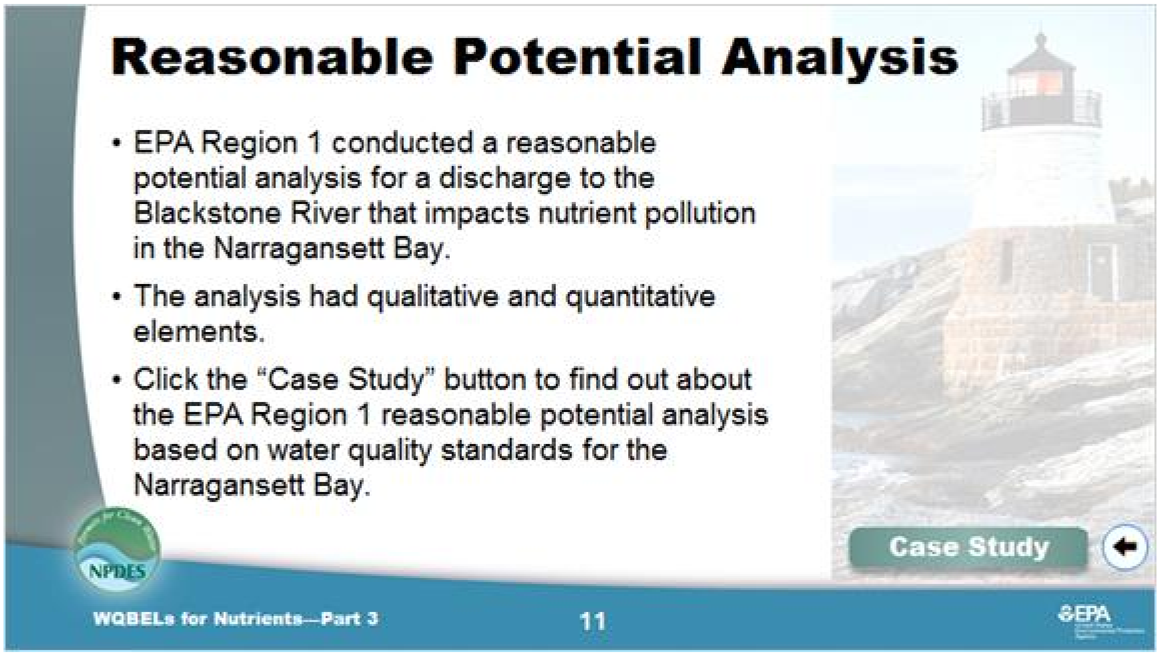


Notes:

Now let's consider the situation where we have the information needed to conduct a quantitative reasonable potential analysis. For a quantitative analysis we will apply procedures that use data characterizing the effluent and receiving water along with numeric nutrient criteria or a numeric interpretation of a narrative criterion to assess whether the discharge would cause, have the reasonable potential to cause, or contribute to an excursion of water quality standards.

Throughout the rest of this training, we are going to focus our attention on a quantitative reasonable potential analysis, but first Danielle will introduce a real life example of a reasonable potential analysis.

1.11 Reasonable Potential Analysis



Notes:

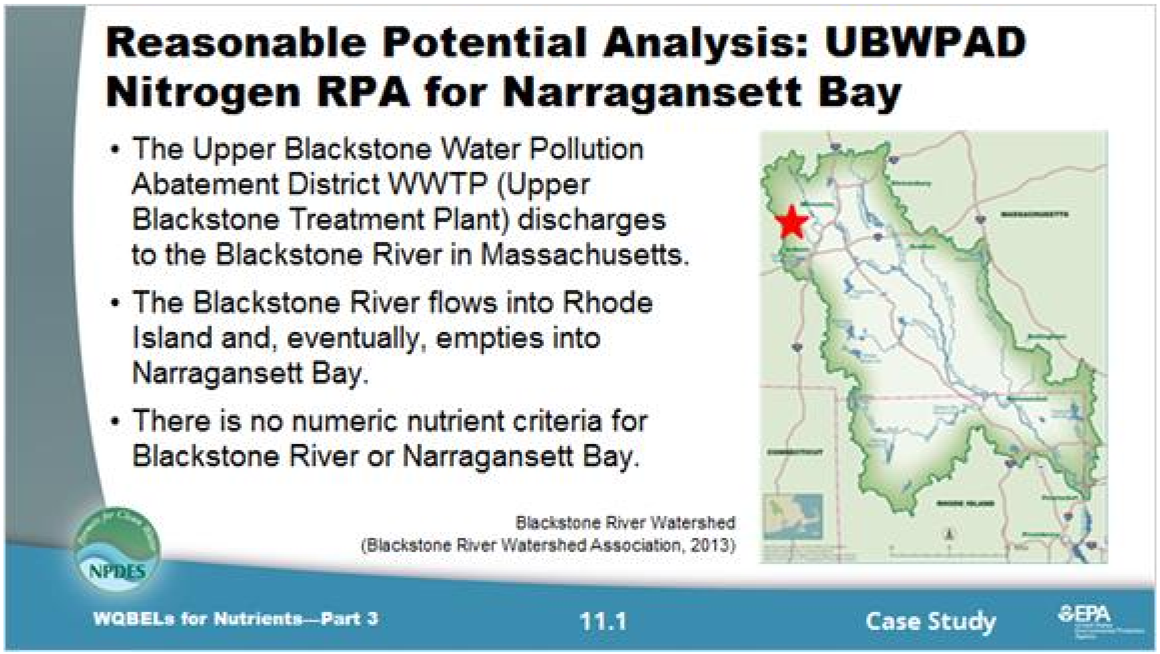
Thanks Nizanna.

EPA Region 1 conducted a reasonable potential analysis for a discharge of nitrogen to the Blackstone River in Massachusetts that affects the downstream Narragansett Bay. There are both qualitative and quantitative aspects to the Region's analysis.

If you would like to view a case study of this reasonable potential analysis, click on the "Case Study" button at the bottom of the slide.

Otherwise, click the "Next" button to skip the case study.

1.12 Reasonable Potential Analysis: UBWPAD Nitrogen RPA for Narragansett Bay



Notes:

Recall that EPA Region 1 is the permitting authority for the state of Massachusetts, as the state has not yet been authorized to administer the NPDES program. EPA Region 1 issued an NPDES permit with effluent limitations for nutrients to the Upper Blackstone Water Pollution Abatement District Wastewater Treatment Plant in Millbury, Massachusetts. From now on, we'll just call the facility the Upper Blackstone Treatment Plant.

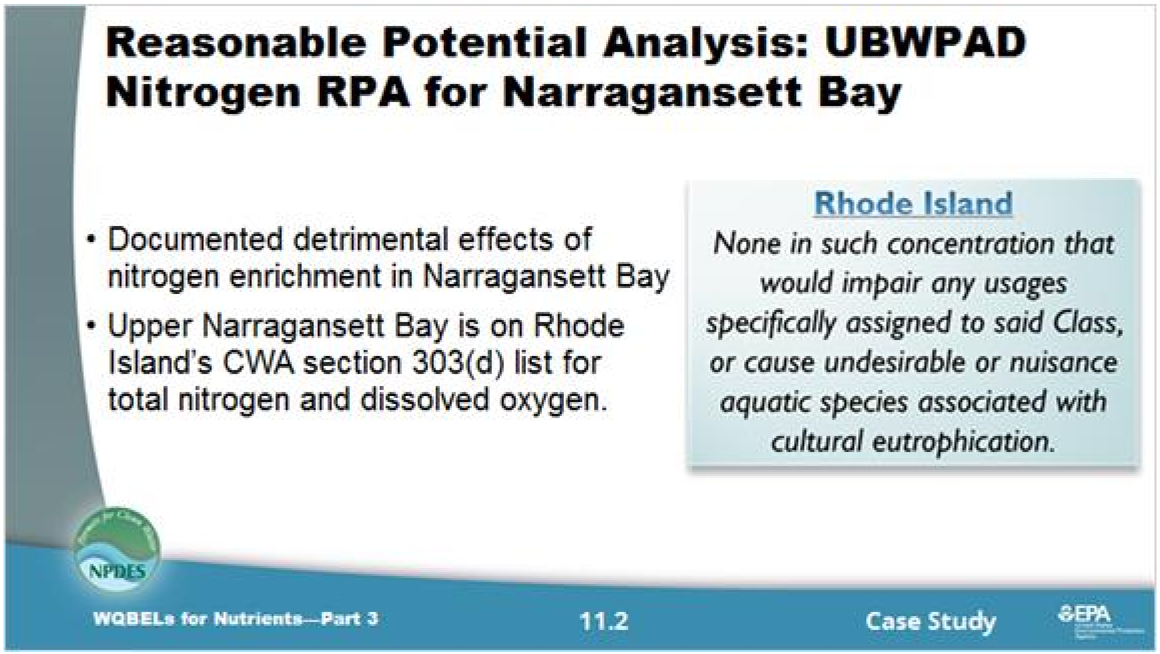
The Blackstone River becomes the Seekonk River, which flows into the Providence River which then empties into the Narragansett Bay in Rhode Island.

When writing the permit for the Upper Blackstone Treatment Plant, EPA Region 1 considered the need for effluent limits based on the water quality standards of both the immediate receiving water and the downstream waters. Specifically, the Region considered the need for total phosphorus limits to protect the Blackstone River in Massachusetts and total nitrogen limits to protect the Narragansett Bay in Rhode Island.

Both Massachusetts and Rhode Island water quality standards must be met, but there are no numeric nutrient criteria for either the Blackstone River or the Narragansett Bay.

For the current discussion, we are going to focus on the bay.

1.13 Reasonable Potential Analysis: UBWPAD Nitrogen RPA for Narragansett Bay



Notes:

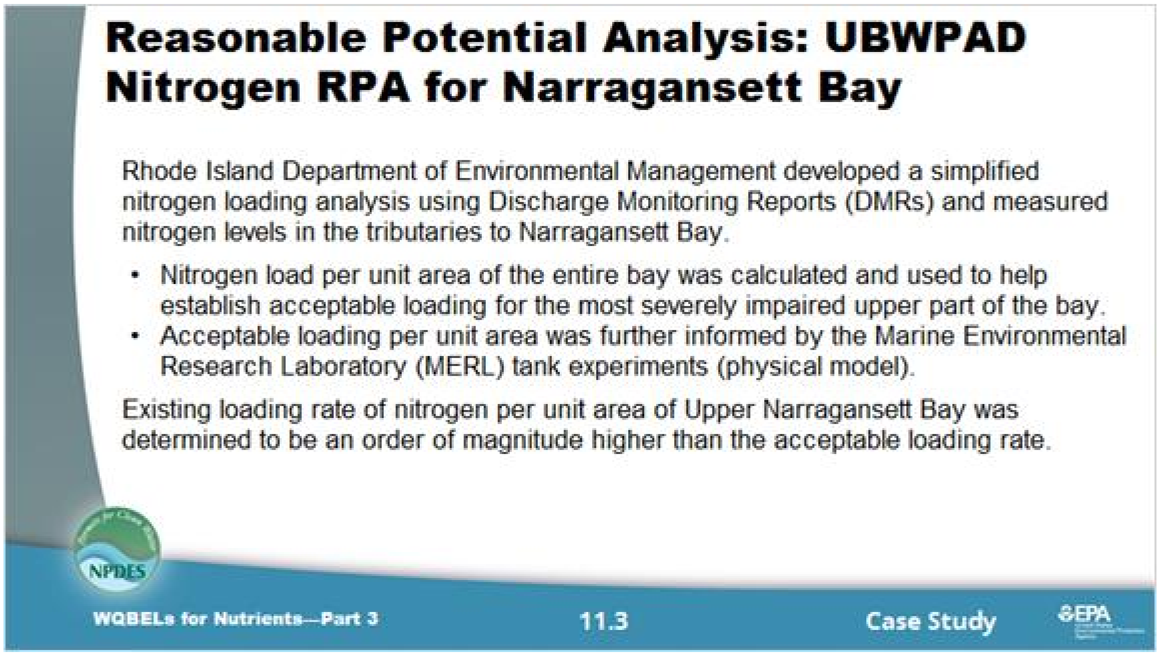
The Rhode Island narrative nutrient criterion (applicable to Narragansett Bay) says that there may be: "None in such concentrations that would impair any usages specifically assigned to said Class, or cause undesirable or nuisance aquatic species associated with cultural eutrophication."

Available data and technical reports clearly document the detrimental effects of nitrogen enrichment in Narragansett Bay.

Impairments include excessive phytoplankton growth, dissolved oxygen violations, and periodic fish kills.

The Upper Narragansett Bay (as well as the Seekonk and Providence Rivers) is listed for an impairment of the fish and wildlife use related to total nitrogen and dissolved oxygen on Rhode Island's Clean Water Act section 303(d) list.

1.14 Reasonable Potential Analysis: UBWPAD Nitrogen RPA for Narragansett Bay



Notes:

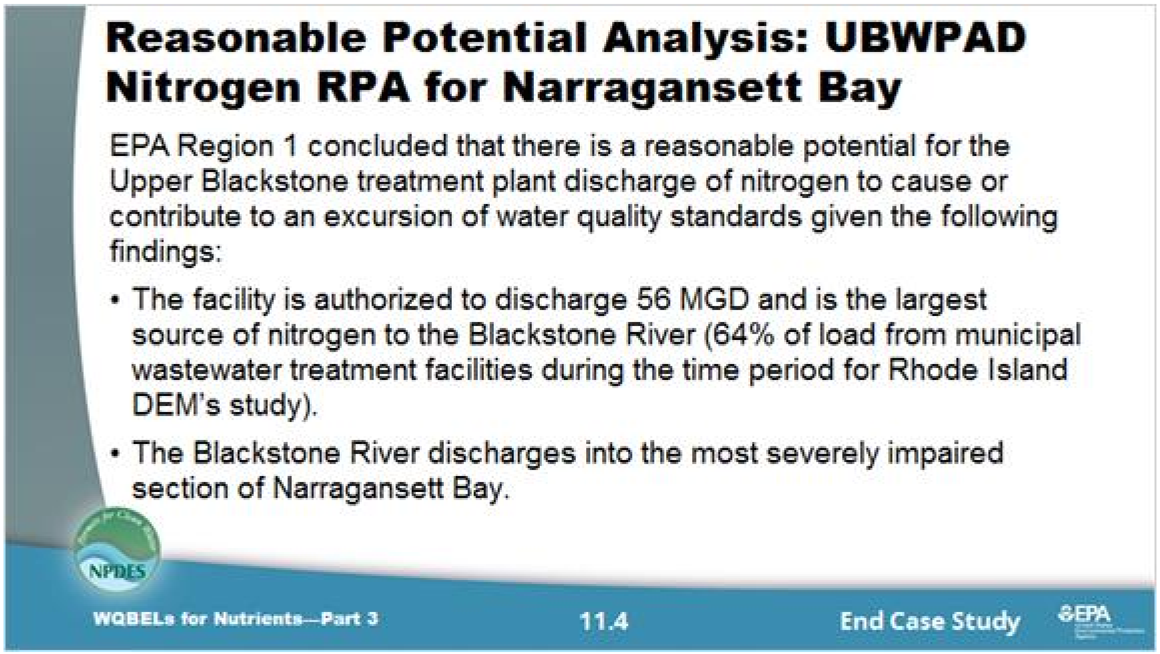
In addition to the Clean Water Act section 303(d) listing, EPA Region 1 took into account a simplified nitrogen loading analysis developed by the Rhode Island Department of Environmental Management using discharge monitoring reports and measured nitrogen levels in the tributaries to Narragansett Bay.

Given that the water quality in the outer reaches of the bay fully supports designated uses, the nitrogen load per unit area of the entire bay was calculated and used to help establish an acceptable loading for the most severely impacted, upper parts of the bay.

The selection of an acceptable load per unit area was further informed by physical experiments conducted by the University of Rhode Island Graduate School of Oceanography's Marine Environmental Research Laboratory. The lab used large reactor tanks that were filled with Narragansett Bay water and then dosed with varying loads of nitrogen.

The existing loading rate of nitrogen per unit area of upper Narragansett Bay was determined to be an order of magnitude higher than the acceptable loading rate.

1.15 Reasonable Potential Analysis: UBWPAD Nitrogen RPA for Narragansett Bay



Notes:

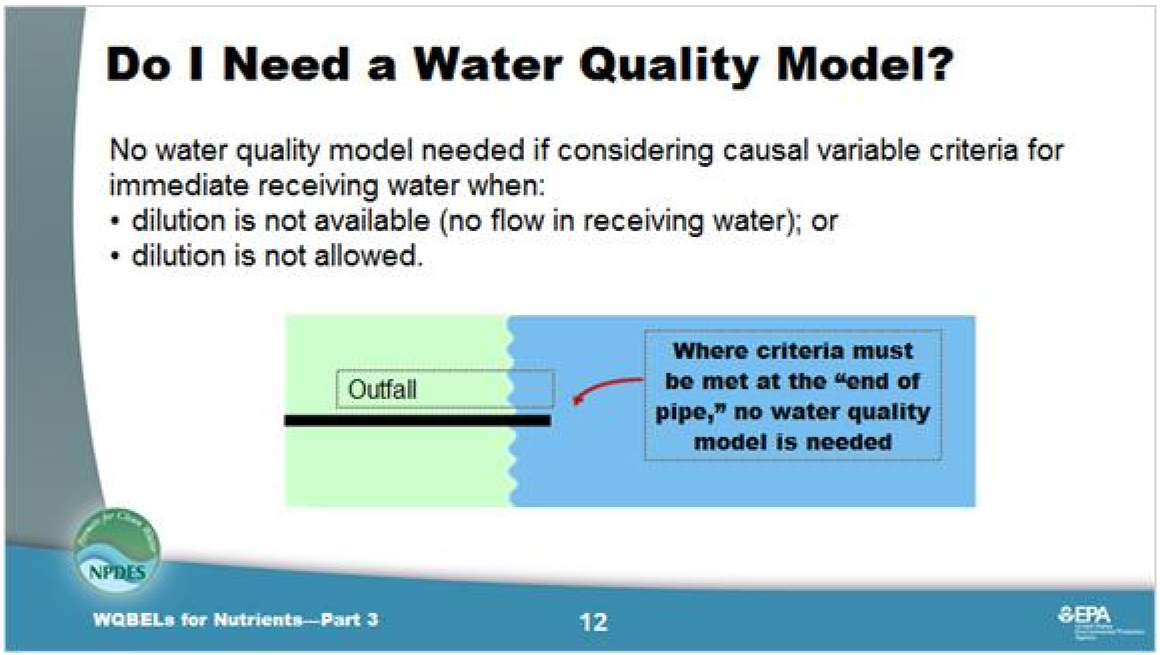
Based on this information, EPA Region 1 concluded that there is reasonable potential for the discharge from the Upper Blackstone Treatment Plant to cause or contribute to an impairment of water quality standards given the following findings:

- First, the Upper Blackstone Treatment Plant's discharge, which is authorized for up to 56 million gallons per day (MGD), was determined to be the largest source of nitrogen to the Blackstone River, accounting for 64% of the nitrogen load from wastewater treatment facilities to the Blackstone River during the study period.
- Second, the Blackstone River, which is the receiving water for the Upper Blackstone Treatment Plant discharge, empties into the most severely impaired section of Narragansett Bay. As already noted, this section of the bay had an existing nitrogen loading rate an order of magnitude higher than the acceptable loading rate.

As previously mentioned, this reasonable potential analysis is somewhat a combination of a quantitative and a qualitative approach. It is based on looking at a numeric loading target for the Narragansett Bay and the relative contribution of nitrogen from the permitted facility, but there was not a specific quantitative analysis of the water body system and the effects of the discharge.

The reasonable potential analysis was challenged and was upheld by EPA's Environmental Appeals Board and in Federal court.

1.16 Do I need a water quality model?



Notes:

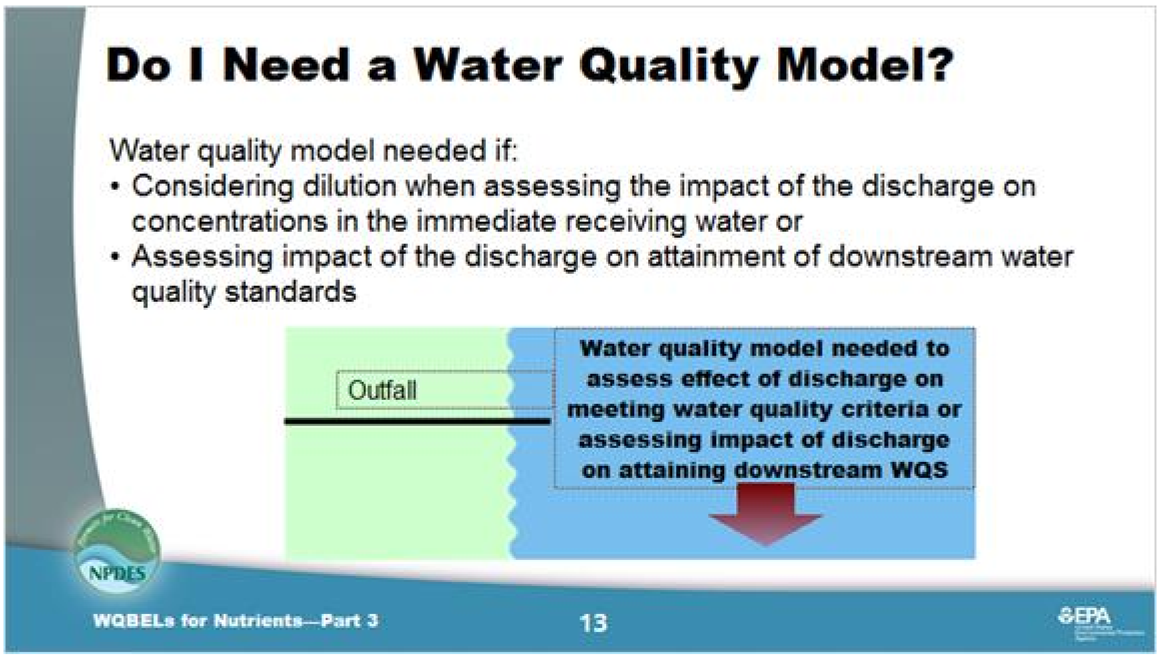
One of the first decisions we need to make when conducting a quantitative reasonable potential analysis is whether we need to use a water quality model and, if so, which model?

Where there is no flow in a receiving water, such as under critical conditions in an arid area, or if no consideration of dilution or a mixing zone is otherwise allowed, effluent limitations must be as stringent as necessary to ensure that water quality criteria are attained right at the point of discharge. You might hear this situation referred to as a requirement to meet "criteria end of pipe."

In such cases, if we only are concerned about attainment of causal variable criteria from water quality standards for the immediate receiving water, we have no need of a water quality model.

Keep in mind, however, that while an outright prohibition on consideration of dilution or mixing zones might be applied in some state water quality standards for certain types of pollutants, such as a bioaccumulative toxic pollutant, such a blanket prohibition is not likely to be in place for nutrients.

1.17 Do I need a water quality model?



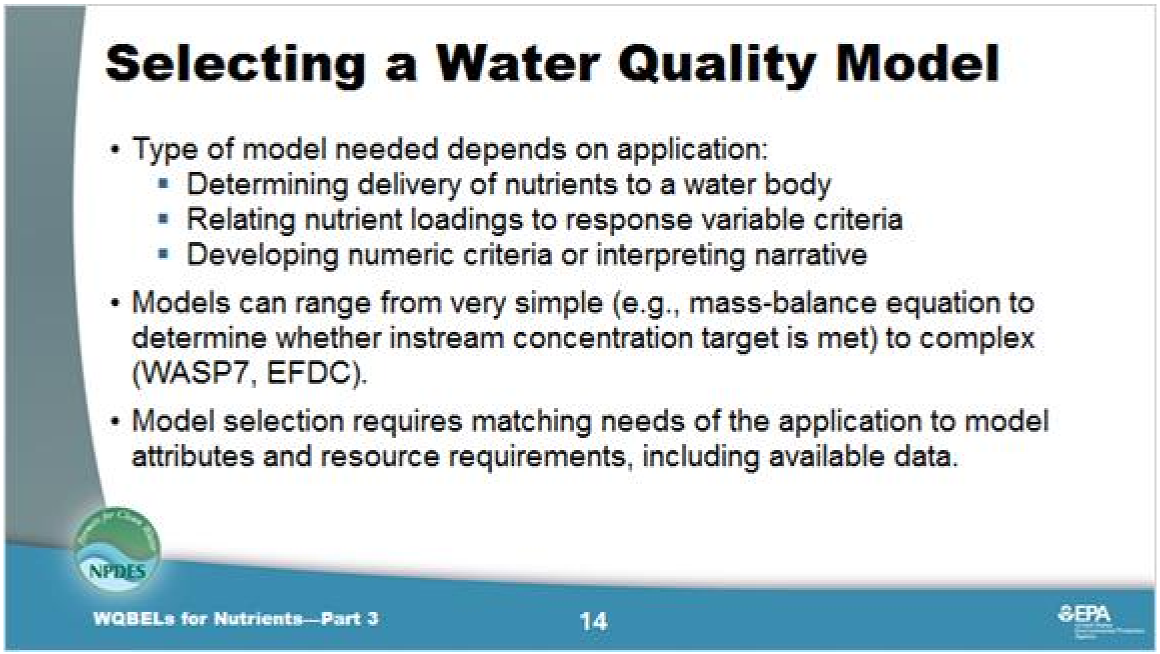
Notes:

Generally, provisions for dilution allowances and mixing zones would apply to nutrients unless separate provisions of the water quality standards specifically state otherwise. EPA has a compilation of mixing zone documents which is provided for you in the Resources tab.

If the water quality standards do allow consideration of dilution or mixing zones for nutrients, then the water quality criteria do not have to be attained "end of pipe." Rather, they must be met in the receiving water after accounting for the allowable dilution or mixing zone and the existing ambient concentration of the pollutant. Assessing a dischargers effect on meeting water quality criteria in the receiving water when dilution or mixing is allowed will require selecting an appropriate water quality model.

We also would need a water quality model if we want to determine the impact of the discharge on attainment of downstream standards.

1.18 Selecting a WQ Model



Notes:

There are a number of steady-state and dynamic water quality models that we could use to support nutrient modeling.

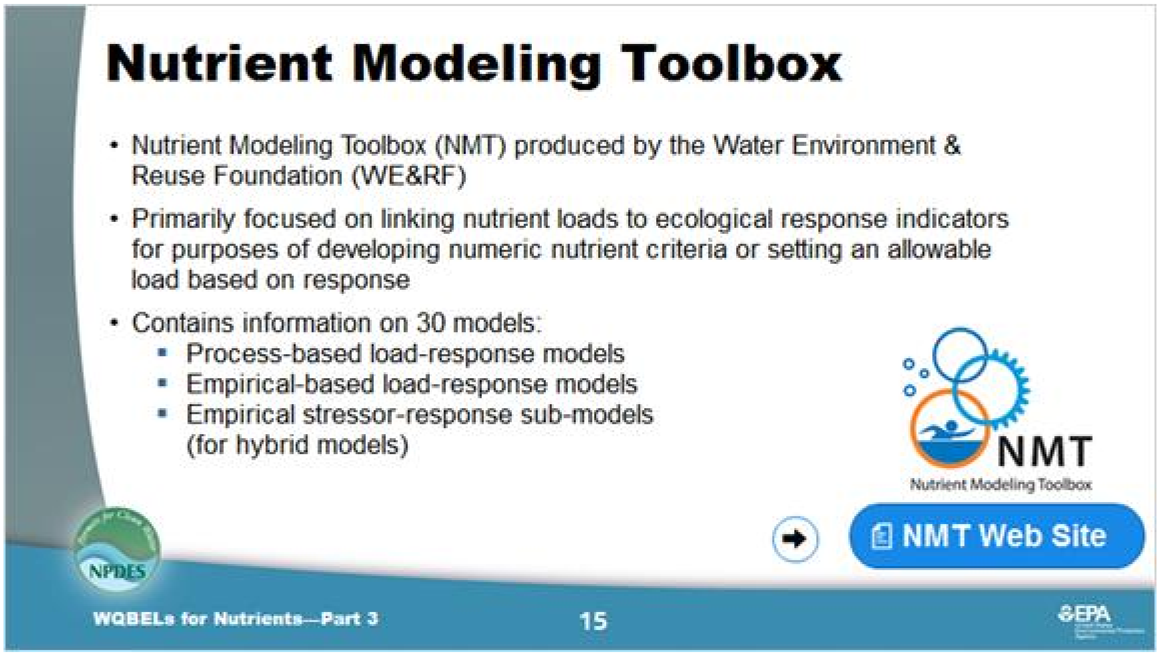
Reviewing these models is beyond the scope of what we could cover in this training. What we will note here is that existing models are used for a number of purposes, from simply determining nutrient delivery to a water body to relating nutrient loadings to response variable criteria to developing nutrient criteria.

We could use a very simple model if we are trying only to determine the impact of a discharge on meeting numeric nutrient criteria in a receiving water or if we can make some simplifying assumptions about how the discharge to a water body affects attainment of nutrient criteria in a downstream water body.

We will need more complex models in situations such as modeling the impact of multiple discharges on a water body, developing a site-specific interpretation of a narrative criterion, or assessing the effects of discharges on attainment of response variable criteria in a downstream water body.

Selecting a water quality model involves thinking about why we need to use a model then matching those needs to an appropriate model with resource requirements, such as required data, that we are able to meet.

1.19 Nutrient Modeling Toolbox



Notes:

Let's look at one tool that permit writers might find useful for selecting a water quality model.

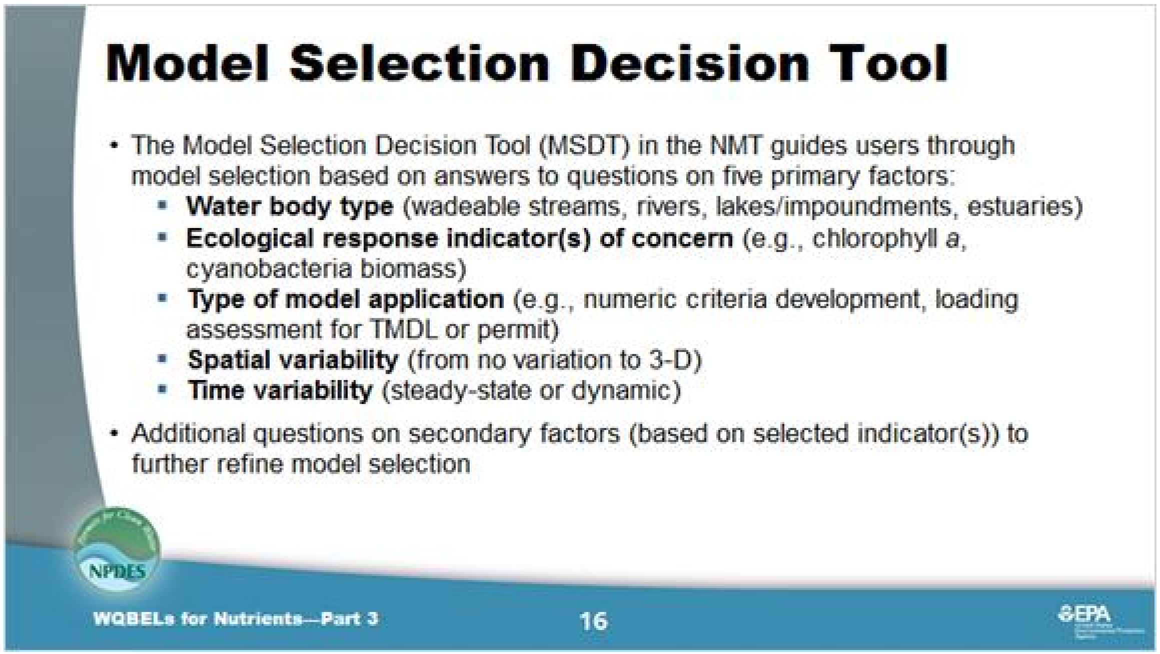
The Water Environment & Reuse Foundation published guidance on the process for development and application of models to support quantitatively linking nutrient loads to water quality and ecological response indicators on a site-specific basis. To accompany this guidance, WE&RF developed the Nutrient Modeling Toolbox. The toolbox helps users identify the correct nutrient model or models for specific technical and management needs.

It focuses on models that can be used to develop numeric nutrient criteria or set an allowable load based on response, such as when developing a TMDL or permit conditions. The toolbox has information on 30 different models, including:

- Process-based load-response models that use mathematical representations of processes that link nutrient loads to in situ water quality and/or ecological responses.
- Empirical load-response models that are based on statistical relationships among empirical observations of nutrient loads and in situ response variables.
- Empirical stressor-response relationships that are relationships between in situ stressors and dependent response variables. They are included in the Toolbox only insofar as they will be linked to a load-response model for providing a hybrid model to extend the analysis to higher level biological or ecological responses such as fish production and macroinvertebrate diversity.

You can download the guidance and the Nutrient Modeling Toolbox at no cost. Just click on the button on this slide.

1.20 Model Selection Decision Tool



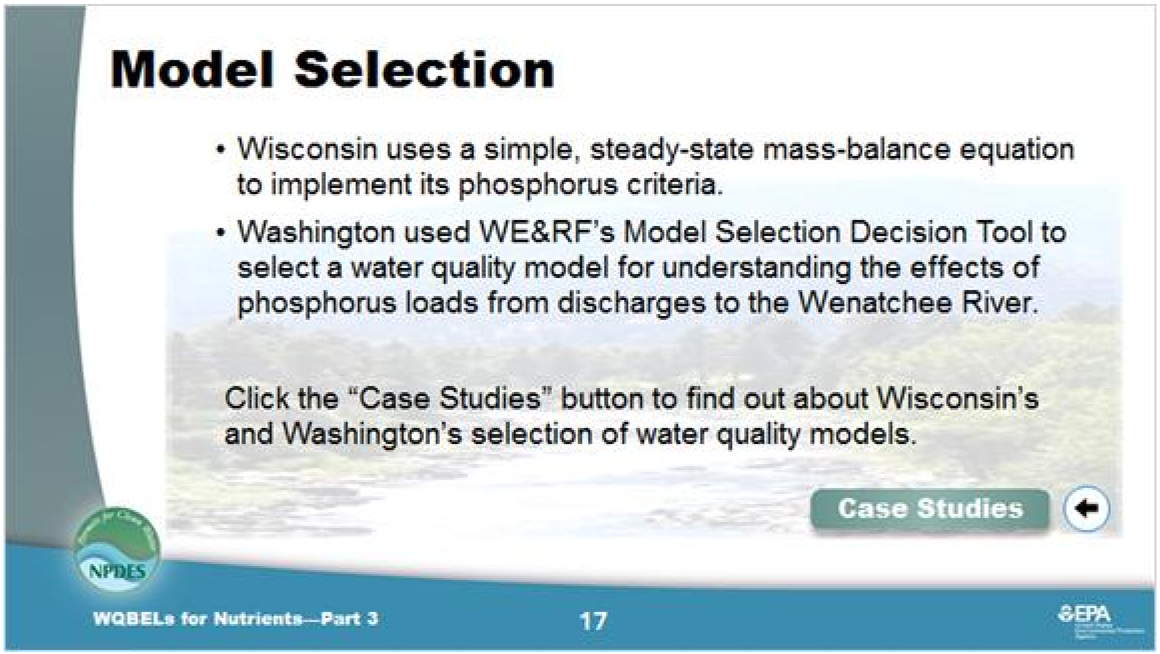
Notes:

Within the Nutrient Modeling Toolbox, a Model Selection Decision Tool guides users through a series of questions related to five primary factors to find the most appropriate water quality model or models for their situation.

The Model Selection Decision Tool begins with a model classification matrix that considers water body type and ecological response endpoints of concern. It then refines model selection with questions on model application, dimensionality, and temporality.

Finally, there are questions on secondary factors. These questions are based on the selected indicators and allow the user to further refine model selection.

1.21 Model Selection



Notes:

Now let's look at a few examples of model selection.

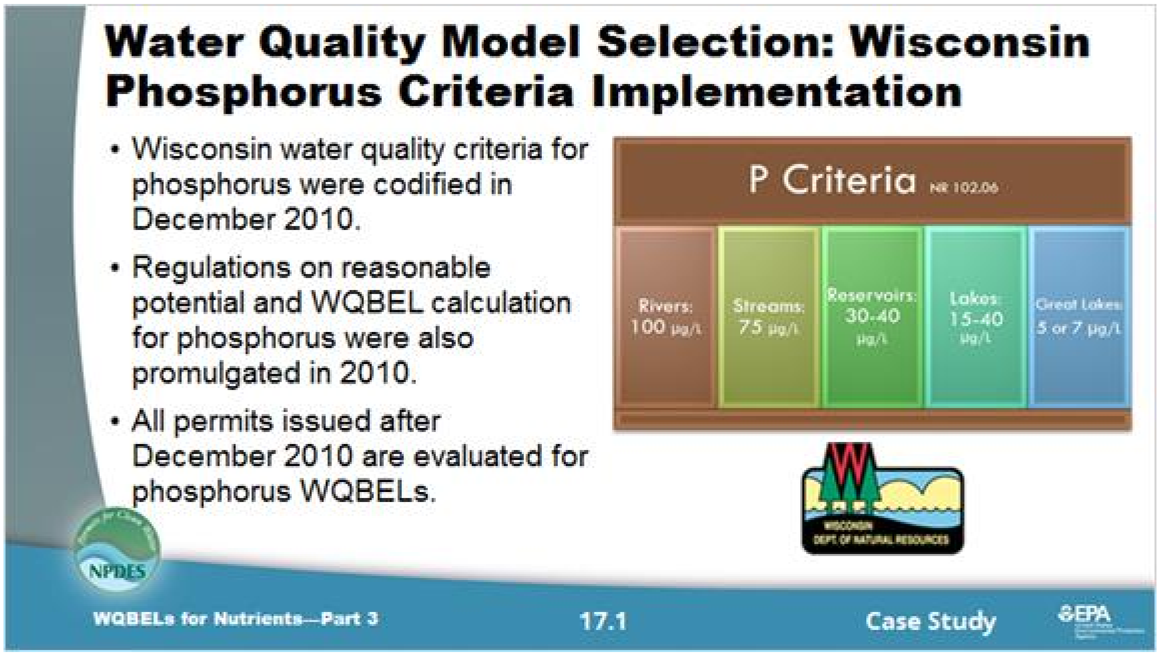
The State of Wisconsin has developed numeric criteria for total phosphorus and uses a simple, steady-state mass balance equation as its model to implement the criteria through NPDES permits.

Washington State used the Water Environment & Reuse Foundation's Model Selection Decision Tool to select a model to assess the effects of phosphorus loads from point source discharges to the Wenatchee River.

If you would like to view case studies on selection and use of these water quality models, click on the "Case Studies" button and Nizanna and I will take you through these examples.

Otherwise, click the "Next" button to skip the case studies.

1.22 Water Quality Model Selection: Wisconsin Phosphorus Criteria Implementation



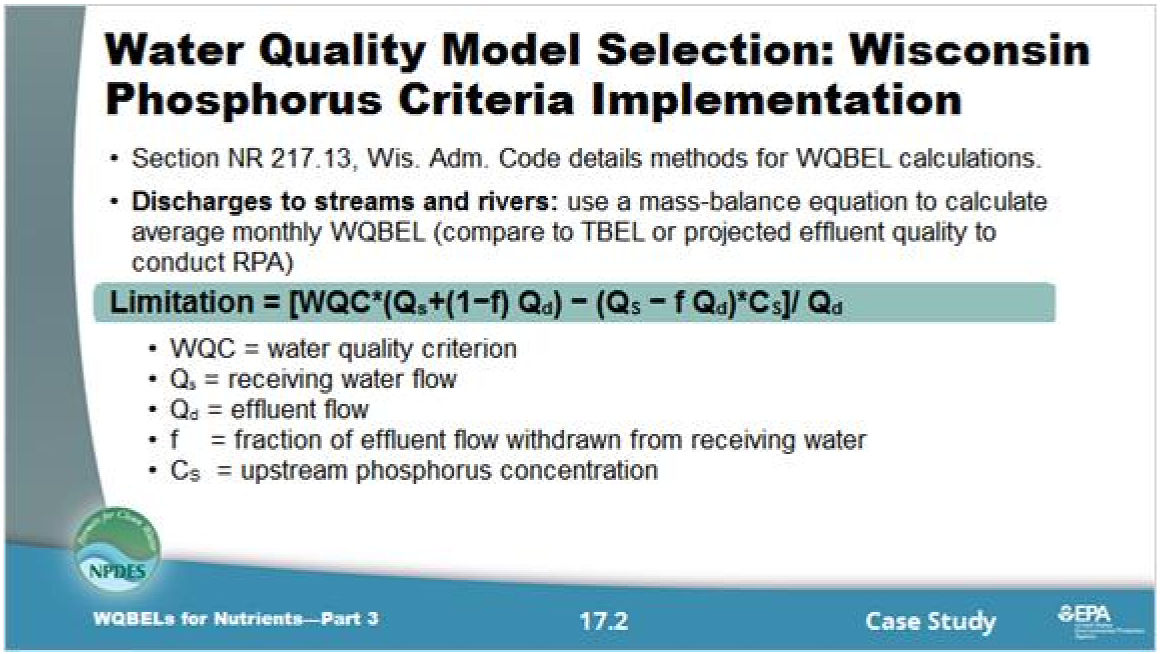
Notes:

In December 2010, Wisconsin established numeric water quality criteria for total phosphorus.

At the same time, the state promulgated regulations on reasonable potential and calculating water quality-based effluent limitations for phosphorus.

Any permit issued after December 2010 has required an evaluation of the need for water quality-based effluent limits that would be derived from water quality criteria for phosphorus.

1.23 Water Quality Model Selection: Wisconsin Phosphorus Criteria Implementation



Notes:

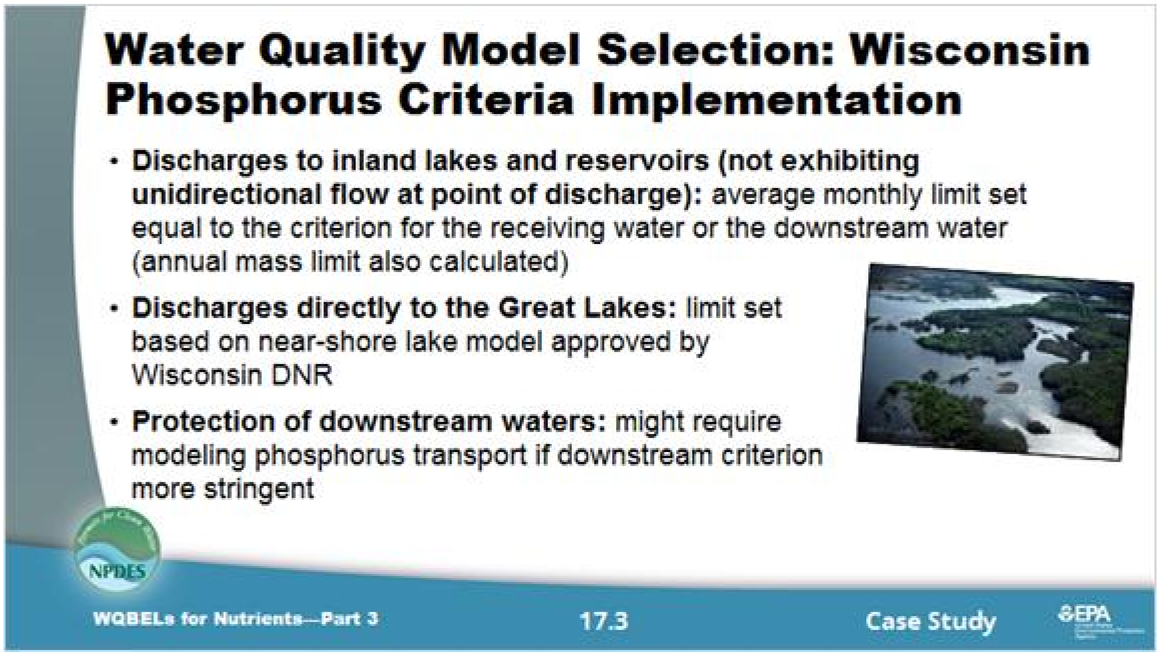
Wisconsin included in its regulations the procedures the state will use to implement the numeric phosphorus criteria.

For discharges to streams and rivers with numeric nutrient criteria, Wisconsin uses a version of a mass balance equation to calculate water quality-based effluent limitations.

Wisconsin conducts a reasonable potential analysis by comparing the water quality-based effluent limitation to the applicable technology-based effluent limitation or, if there is no technology-based effluent limit, to the projected effluent quality of the discharge.

If the calculated technology-based effluent limit or projected effluent quality exceeds the calculated water quality-based effluent limit, then there is "reasonable potential" and the calculated water quality-based effluent limit must be included in the permit.

1.24 Water Quality Model Selection: Wisconsin Phosphorus Criteria Implementation



Notes:

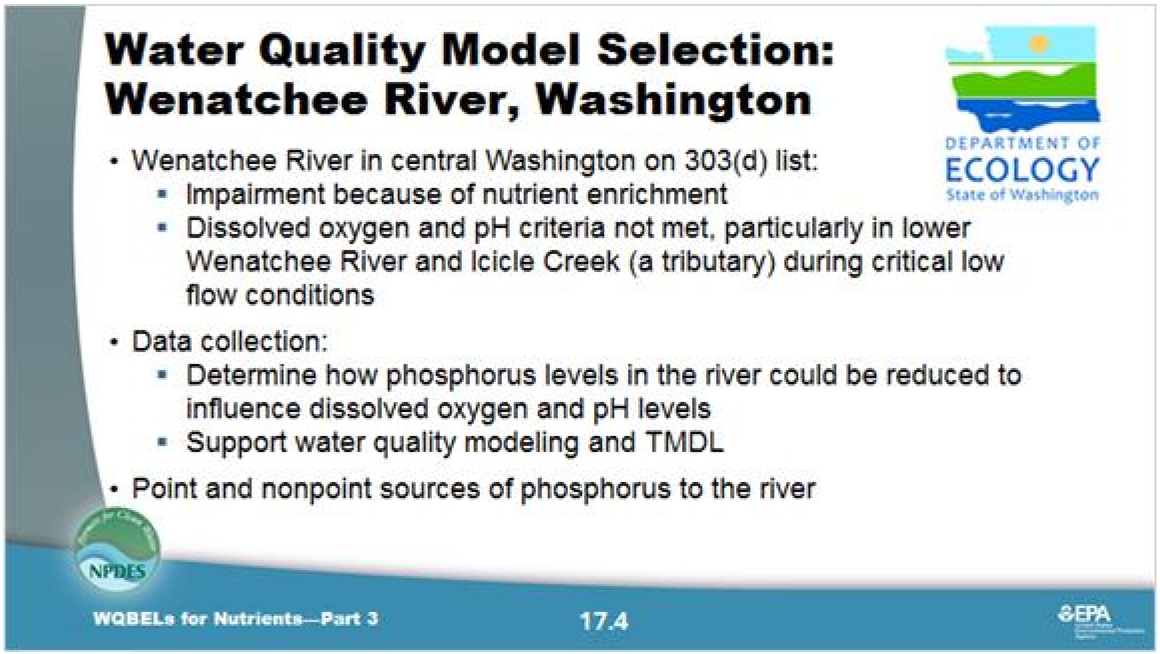
For completeness, we should also note that, for inland lakes and reservoirs, and the Great Lakes, the processes are a bit different.

For inland lakes and reservoirs, Wisconsin directly applies its phosphorus criterion as the average monthly limit in the facility's permit.

For the Great Lakes, limits are set based on a near-shore lake model approved by the Wisconsin Department of Natural Resources.

In its procedures, the state recognizes that additional modeling might be needed to account for downstream waters with more stringent criteria.

1.25 Water Quality Model Selection: Wenatchee River, Washington



Notes:

Here is an example of the selection of a more complex water quality model from the State of Washington.

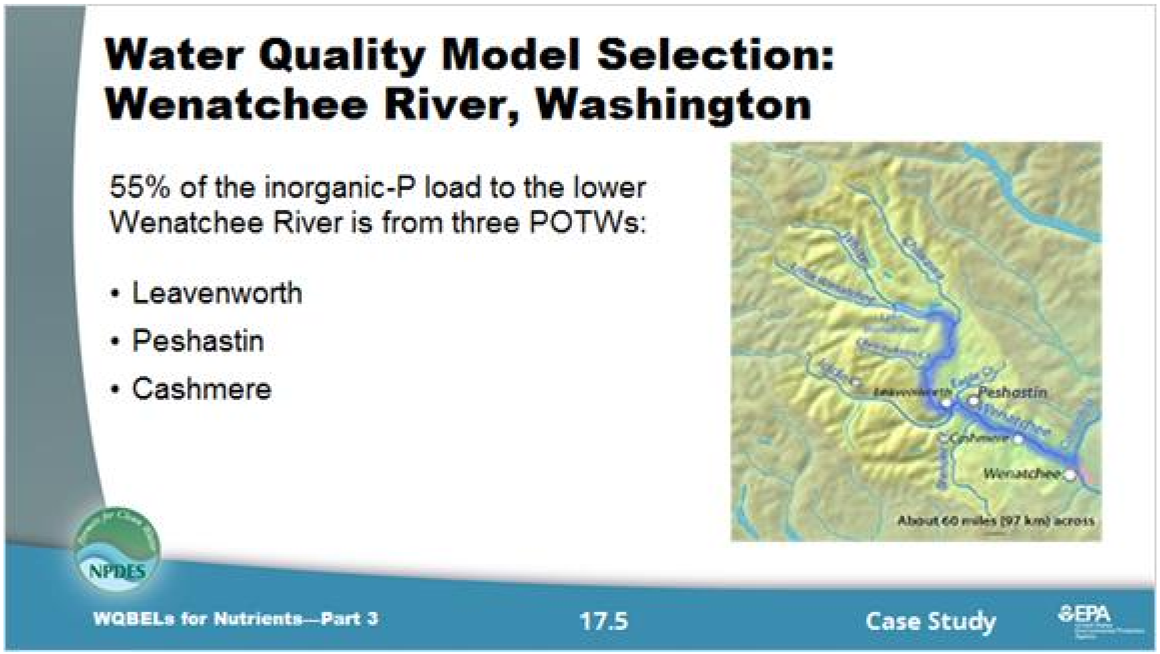
The Wenatchee River, in central Washington, was listed on Washington's 1998 303(d) list because of nutrient enrichment. Effects of this enrichment included non-attainment of pH and dissolved oxygen water quality criteria, particularly in the lower Wenatchee River and Icicle Creek, a tributary.

The dissolved oxygen and pH criteria do not have specific duration and frequency components. Dissolved oxygen values are listed as "Dissolved oxygen shall exceed…" and pH criteria are listed as "Shall be within the range…"

Washington collected data to confirm the influence of phosphorus on criteria attainment and to support a water quality model for purposes of completing a TMDL. The study and the TMDL looked at how phosphorus levels in the river would affect attainment of pH and dissolved oxygen criteria. It also established targets and load allocations and wasteload allocations of phosphorus that would lead to attainment of the criteria.

Sources of phosphorus to the Wenatchee River include wastewater treatment plants, fish hatcheries, and fruit processors. There are also nonpoint sources, including agriculture, on-site septic systems, and forestry.

1.26 Water Quality Model Selection: Wenatchee River, Washington



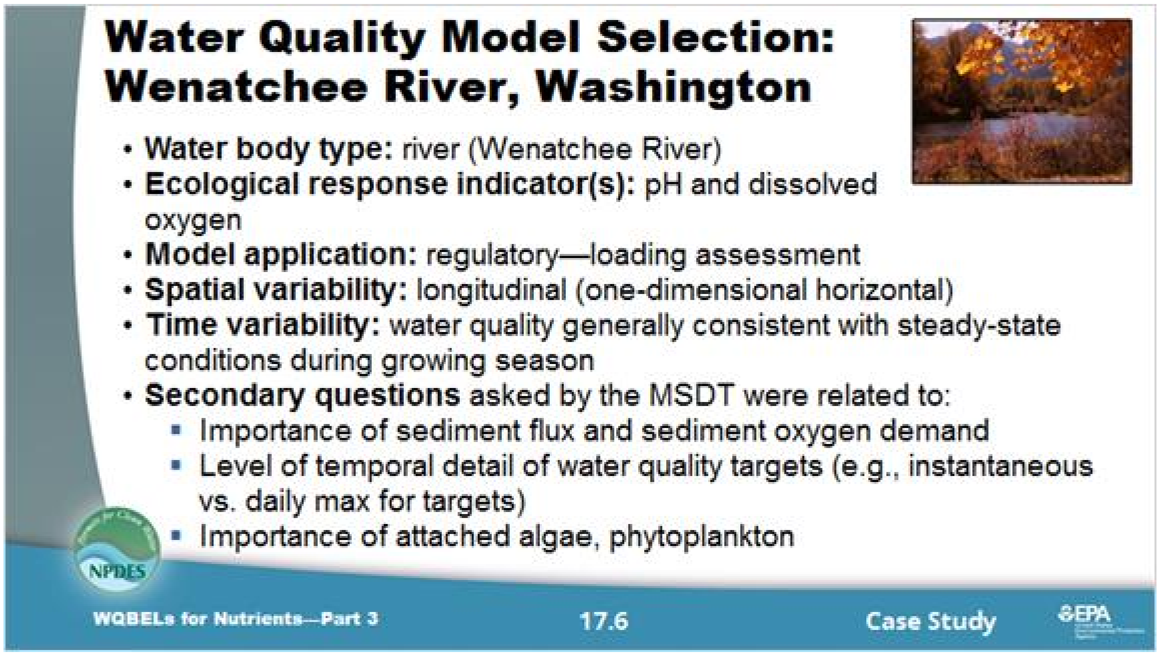
Notes:

This study was particularly important for NPDES permitting because it is a watershed where point sources play a significant role in nutrient pollution.

Around 55% of the inorganic phosphorus load to the lower Wenatchee River was found to come from three publicly-owned treatment works-Leavenworth, Peshastin, and Cashmere.

About 40% of the load was from diffuse sources, including natural background, and the remainder from tributaries to the river.

1.27 Water Quality Model Selection: Wenatchee River, Washington



Notes:

The Washington Department of Ecology selected a water quality model by using the WE&RF Model Selection Decision Tool.

Here are the five key inputs to the Model Selection Decision Tool for the Wenatchee River study.

The water body is a river, of course, and the responses of concern had been identified as pH and dissolved oxygen levels.

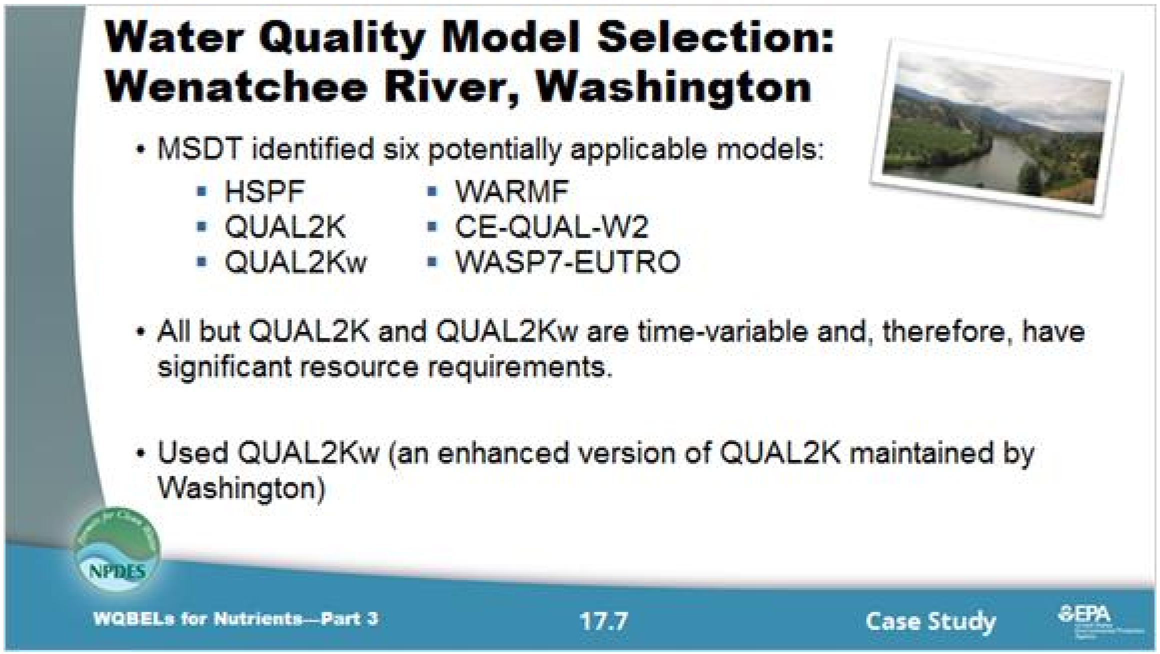
The model was being applied for regulatory purposes-developing a TMDL that would set applicable loads for attainment of pH and dissolved oxygen criteria and, ultimately, become the basis for water quality-based effluent limitations.

In this case, a description of the lateral variation in attached algal growth was not required, so the water body could be modeled in one dimension, looking only at horizontal variation in attached growth.

As far as time variability, Washington was able to use a steady-state model because the water quality in the river was generally consistent with steady state conditions during the growing season of March through October.

The Model Selection Decision Tool also included some secondary questions. Of particular significance were questions related to the level of temporal detail of the pH and dissolved oxygen targets and the importance of attached algae in pH and dissolved oxygen balance.

1.28 Water Quality Model Selection: Wenatchee River, Washington



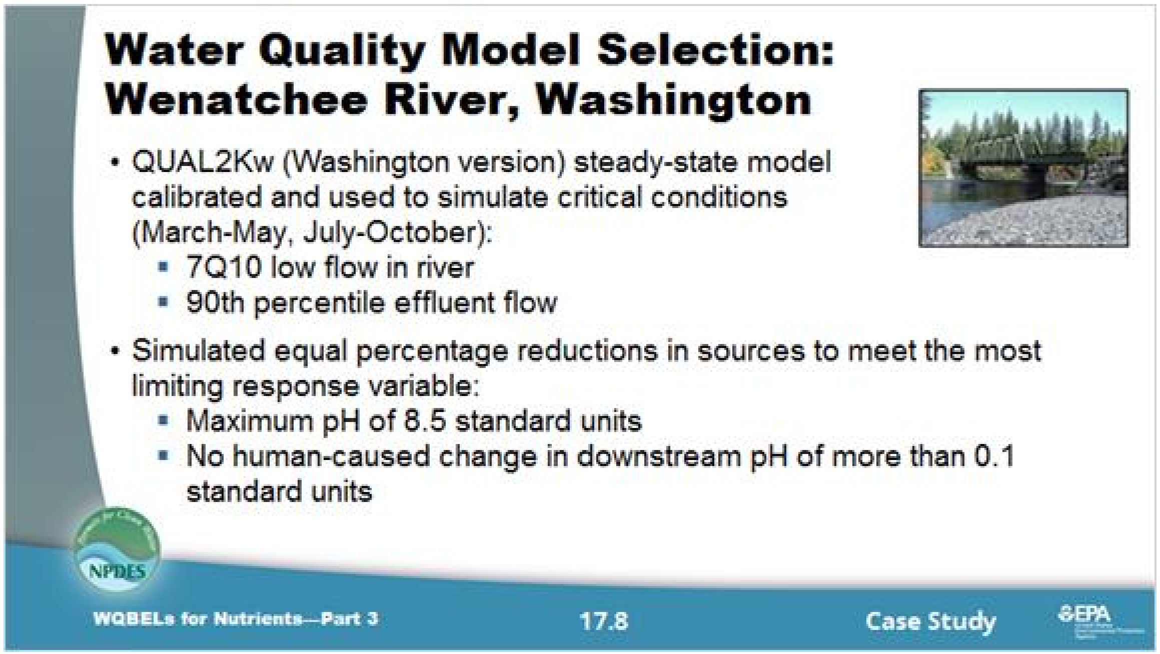
Notes:

The Model Selection Decision Tool used the five key inputs and answers to the secondary questions to identify potentially applicable models.

The Tool identified six models that could be used, but most were time variable and, therefore, would have significant resource requirements.

Matching up appropriate models with resource requirements and resource availability, the Washington Department of Ecology selected the QUAL2K model, which is often used in streams and rivers. Washington modified and maintains a version of QUAL2K for their geographic region. This model, QUAL2Kw, was used for the Wenatchee.

1.29 Water Quality Model Selection: Wenatchee River, Washington

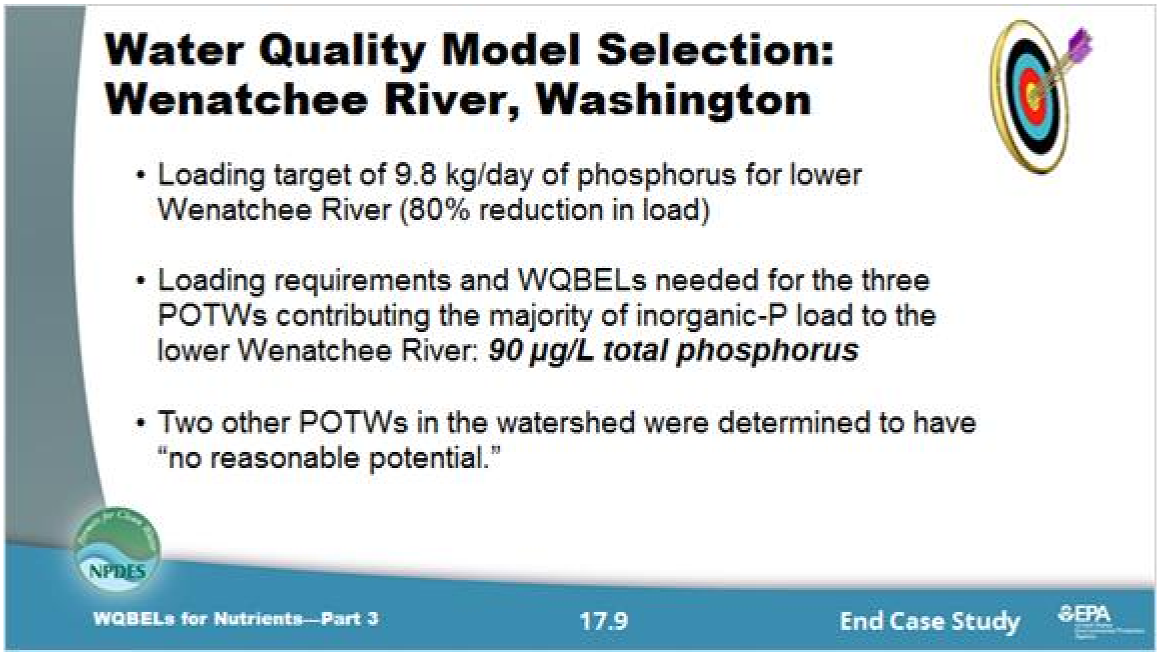


Notes:

Washington collected supporting data to calibrate the model to the late-summer growing season. Washington then applied the model at critical conditions, namely the 7Q10 low flow of the river and the 90th percentile effluent flow, during the critical periods of March through May and July through October. These months are when the river has relatively low stream flows. The critical period is interrupted as a result of increased stream flow from snowmelt that occurs from late May to early July.

The model was used to simulate reductions in inorganic phosphorus load from all point and nonpoint sources by an equal percentage until the pH criteria were achieved. These criteria are an upper pH of 8.5 standard units and a requirement for no human-caused change in downstream pH of more than 0.1 standard units. The entire lower river was treated as a compliance point.

1.30 Water Quality Model Selection: Wenatchee River, Washington



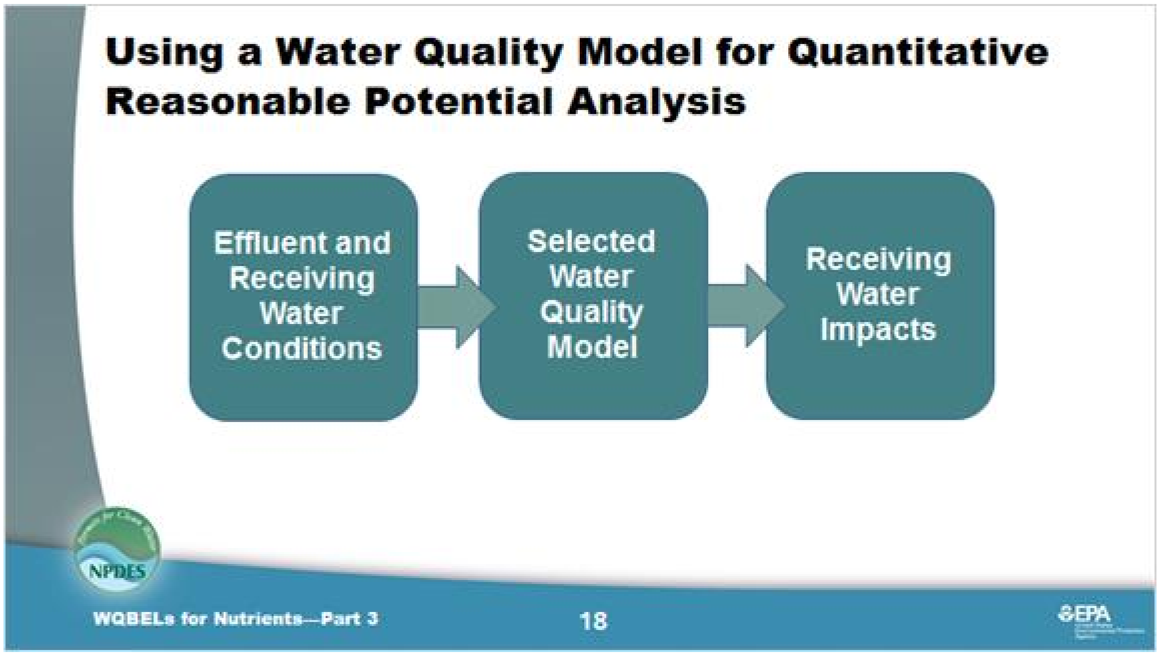
Notes:

The resulting total phosphorus target was a load of 9.8 kg/day from all sources, or approximately an 80% reduction in overall loading.

The TMDL concluded that the three publicly-owned treatment works on the lower Wenatchee that contributed 55% of the inorganic phosphorus loading would need water quality-based effluent limitations based on a maximum daily discharge concentration of 90 µg/L of total phosphorus.

According to the TMDL, two other treatment plants holding NPDES permits in the Wenatchee River watershed would not receive wasteload allocations based on the conclusion that, due to their seasonal nature, their discharges did not contribute to the dissolved oxygen and pH violations in the watershed.

1.31 Using a Water Quality Model for Quantitative Reasonable Potential Analysis



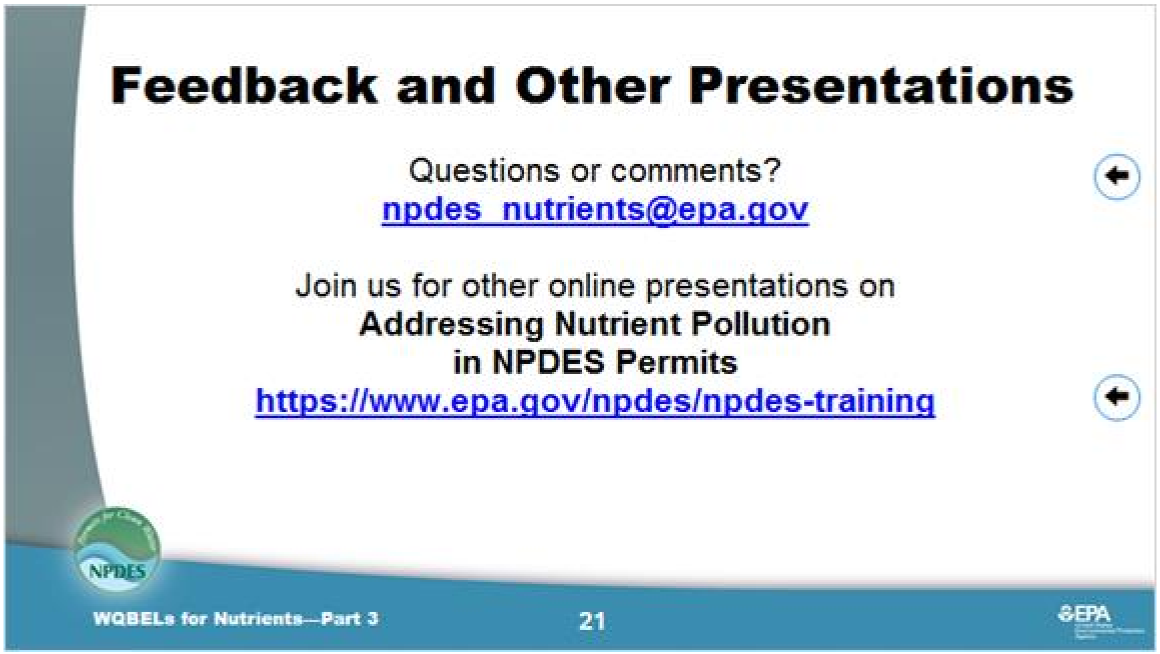
Notes:

So, where are we in the process of determining the need for water quality-based effluent limitations?

At this point, we have selected a water quality model that will help us assess the impact of the discharge on the receiving water.

In our next presentation, we'll consider how we apply the selected water quality model, including choosing the appropriate critical conditions to use as model inputs, to conduct a quantitative reasonable potential analysis for nutrients.

1.39 Feedback and Other Presentations



Notes:

Congratulations on completing the quiz and this presentation!

If you have questions or comments on this presentation or any part of this training curriculum, you can email npdes_nutrients@epa.gov.

Remember, you will find all NPDES online training presentations, under the “Training” section of USEPA’s NPDES website.

Thanks again for joining us!