NPDES PERMIT WRITERS' SPECIALTY WORKSHOP
ADDRESSING NUTRIENT POLLUTION IN NPDES PERMITS
GROUP EXERCISE—SCENARIO B

INTRODUCTION

The Anytown Wastewater Treatment Plant is a publicly-owned treatment works (POTW). The facility has submitted its application for re-issuance of its National Pollutant Discharge Elimination System (NPDES) permit. The POTW discharges via Outfall 001 to Sparkling River at a point two (2) miles upstream of where the river enters Shimmering Lake. Sparkling River and Shimmering Lake are located in the Southeastern Temperate Forested Plains and Hills (Ecoregion IX) and their designated uses include aquatic life habitat and propagation and recreation uses. Shimmering Lake has an average residence time of approximately 65 days.

Shimmering Lake was listed on the most recent Clean Water Act (CWA) section 303(d) list as impaired, with the cause listed as "nutrients." A TMDL will not be completed for at least four years. Over the past two years, there have been periodic nuisance algal blooms and low dissolved oxygen levels in Shimmering Lake. Sparkling River is not included on the 303(d) list; however, there also have been periodic occurrences of nuisance algal blooms in Sparkling River (between Anytown's Outfall 001 and the mouth of the river and at points upstream of Anytown) over the past two years, indicating that it too is threatened by nutrient over-enrichment.

The state included effluent limitations and monitoring requirements for ammonia nitrogen (to prevent aquatic toxicity) and monitoring requirements for TKN, nitrate+nitrite, and total phosphorus in the current NPDES permit issued to the Anytown POTW. The plant operates its existing treatment system to achieve some nitrogen and phosphorus removal, anticipating a potential future need to reduce its discharge of nutrients. Nitrogen and phosphorus requirements in the current permit are as follows:

Parameter	Maximum Daily Limitation	Average Monthly Limitation
Ammonia (NH_3) (as N)	9.0 mg/L	4.5 mg/L
Total Kjeldahl Nitrogen (TKN)* (as N)	Monitor Only	
Nitrate + Nitrite Nitrogen (as N)	Monitor Only	
Phosphorus (total as P)	Monitor Only	

* organic nitrogen + ammonia

The state has collected effluent flow and nutrient concentration data for the Anytown POTW as well as receiving water data on Sparkling River upstream of Outfall 001. Also, the state has some policies and procedures in place related to determining the need for and calculating water quality-based effluent limitations (WQBELs), though most of these procedures were developed to address toxic pollutants.

ASSIGNMENT

Your group's task in this exercise is to make key decisions on interpretation of nutrient water quality criteria, critical conditions for water quality modeling, procedures for calculating water quality-based effluent limitations (WQBELs) for nutrients, and other permit conditions, and be prepared to discuss the basis for those decisions. Questions posed in each part of the exercise will guide your group's discussion and decision making. You will keep track of your decisions on the answer sheets provided. The instructors also will track your answers and show how they affect the WQBELs for the Anytown POTW.

PART 1: IDENTIFY THE APPLICABLE WATER QUALITY STANDARDS

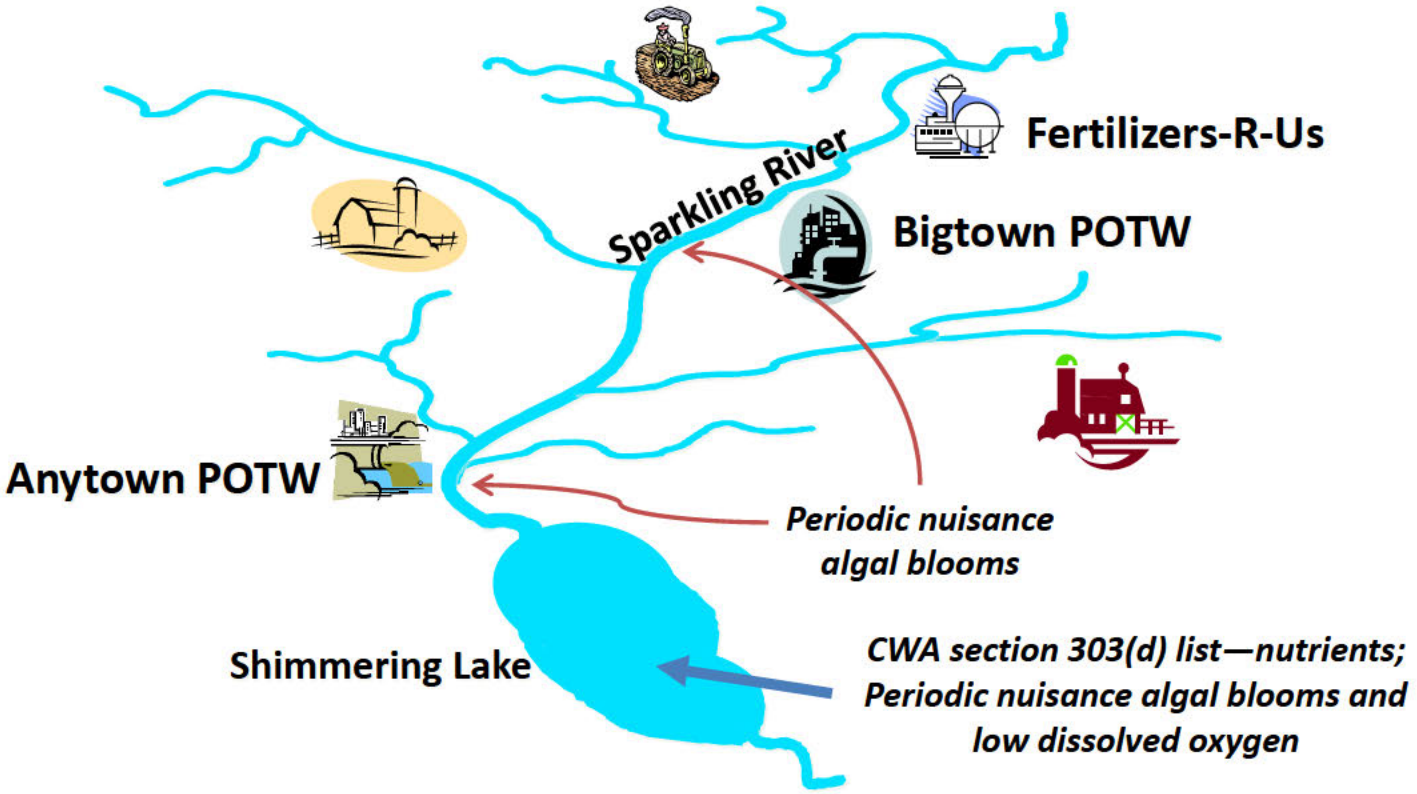
NARRATIVE WATER QUALITY CRITERION FOR NUTRIENTS—ALL SURFACE WATERS

- Waters shall be free from nutrients in concentrations that lead to growth of aquatic weeds or algae that impair any designated use.

- The state water quality standards include a narrative nutrient criterion that applies to all surface waters, including Shimmering Lake and Sparkling River. The state has not developed numeric nutrient criteria for Shimmering Lake or Sparkling River and does not have a specific policy or procedure for interpreting its narrative nutrient criterion.

- There is an **approved TMDL for total phosphorus for Clear Lake** (a lake in the same basin (HUC-6) with conditions similar to those in Shimmering Lake). Water quality standards for Clear Lake do not include numeric nutrient criteria; therefore, the TMDL target for Clear Lake of **34 µg/L total phosphorus (as P) as a 30-day average not to be exceeded more than once in three years** is based on interpretation of the narrative nutrient criterion.

SHIMMERING LAKE/SPARKLING RIVER WATERSHED



SHIMMERING LAKE— INTERPRETATION OF NARRATIVE CRITERION

Decision 1: Select from among various options for interpreting the narrative nutrient criterion for Shimmering Lake in this permit. **Choose one option for each parameter (total phosphorus and total nitrogen) and record your selections on the Answer Sheet for this portion of the exercise.**

Parameter	Shimmering Lake—Options for Application of Numeric Criterion
Total Phosphorus (TP)	***Option 1:*** EPA Ecoregion IX criterion for lakes and reservoirs of 20 µg/L applied as an annual average, not to be exceeded
	Option 2: EPA Gold Book value for lakes and reservoirs of 25 µg/L applied as a 30-day average, not to be exceeded more than once in three years
	Option 3: TMDL target for Clear Lake of 34 µg/L applied as a 30-day average, not to be exceeded more than once in three years
	Option 4: Do not interpret the narrative criterion as a total phosphorus target for Shimmering Lake in this permit
Total Nitrogen (TN)	***Option 1***: EPA Ecoregion IX criterion for lakes and reservoirs of 0.36 mg/L applied as an annual average, not to be exceeded
	Option 2: Do not interpret the narrative criterion as a total nitrogen target for Shimmering Lake in this permit

SPARKLING RIVER—INTERPRETATION OF NARRATIVE CRITERION

Decision 2: Select from among various options for interpreting the narrative nutrient criterion for Sparkling River in this permit. **Choose one option for each parameter (total phosphorus and total nitrogen) and record your selections on the Answer Sheet for this portion of the exercise.**

Parameter	Sparkling River—Options Interpretation of Narrative Criterion
Total Phosphorus (TP)	***Option 1:*** EPA Ecoregion IX criterion for rivers and streams of 37 µg/L as an annual average, not to be exceeded
	Option 2: EPA Gold Book value for rivers and streams (at the point where they enter a lake or a reservoir) of 50 µg/L as a 30-day average, not to be exceeded more than once in three years
	Option 3: EPA Gold Book value (for all other rivers and streams) of 100 µg/L as a 30-day average, not to be exceeded more than once in three years
	Option 4: Do not interpret the narrative criterion as a total phosphorus target for Sparkling River in this permit
Total Nitrogen (TN)	***Option 1:*** EPA Ecoregion IX criterion for rivers and streams of 0.69 mg/L as an annual average, not to be exceeded
	Option 2 Do not interpret the narrative criterion as a total nitrogen target for Sparkling River in this permit

PART 2: DETERMINE THE NEED FOR WQBELS

For the Anytown POTW permit, the state has decided to use a steady-state water quality modeling approach to determine the need for WQBELs to protect both Sparkling River and downstream Shimmering Lake. **In order to simplify calculations in this exercise, the steady state approach used here will be a mass-balance equation**, stated as follows:

$$Q_r \times C_r = (Q_d \times C_d) + (Q_s \times C_s)$$

To determine the need for WQBELs ("reasonable potential"):

$$C_r = \frac{(Q_d \times C_d) + (Q_s \times C_s)}{(Q_r)}$$

where:

C_r	=	projected downstream receiving water concentration (to compare to criterion)
Q_d	=	critical effluent flow
C_d	=	critical effluent pollutant concentration
Q_s	=	critical upstream receiving water flow
C_s	=	critical upstream receiving water pollutant concentration
Q_r	=	critical downstream receiving water flow

DILUTION AND MIXING ZONE POLICY

The state established a dilution and mixing zone policy specifying the maximum dilution that may be considered in steady-state water quality modeling. This policy addresses dilution and mixing in the immediate receiving water and when considering downstream water bodies.

- **If a water quality criterion of concern is for the immediate receiving water (in this case, Sparkling River) and there is rapid and complete mixing, state policy allows up to 50% of the critical flow of the receiving water to be used steady-state modeling.**

- **In the absence of a nutrient transport model, when the water quality criterion of concern is for a downstream water body (in this case, Shimmering Lake) and there is rapid and complete mixing with the immediate receiving water, state policy allows up to 100% of the critical flow of the immediate receiving water to be used in a steady-state model. This approach accounts for the potential for additional mixing and dilution of the effluent between the point of discharge and the downstream water body.**

The state determined that **there is rapid and complete mixing** of the effluent and the immediate receiving water; therefore, **the full amount of dilution allowed under the state's dilution and mixing policy will be considered in all modeling calculations**.

CRITICAL CONDITIONS IN STEADY-STATE MODELING

Taking a steady-state modeling approach to determine the need for water quality-based effluent limitations (and to calculate limitations where they are needed), requires **selection of critical conditions for both the receiving water and the effluent**. In its water quality standards and policies, the state has defined the critical conditions to use when addressing criteria for toxic pollutants and similar pollutants. The state has not determined how these policies might apply or be adapted to apply to nutrients. Without a defined policy, permit writers have flexibility in defining the conditions to use in steady-state modeling approaches. A discussion of these critical conditions and the options available to permit writers follows.

CRITICAL CONDITIONS—RECEIVING WATER

CRITICAL UPSTREAM RECEIVING WATER FLOW (Q_s IN THE MASS-BALANCE EQUATION)

Existing Policy

- State water quality standards implementation policies include hydrologically-based critical flow values that apply when implementing aquatic life criteria (***1Q10 for acute and 7Q10 for chronic***) and ***human health criteria (harmonic mean flow) for toxics and similar pollutants***.

Possible Adaptations for Nutrients

- State water quality standards policies do not specifically mention critical flow values for nutrients.
- The state is ***considering using the harmonic mean flow or 30Q5 low flow*** as the critical receiving water flow when implementing ***annual average nutrient criteria***.
- The state is ***considering using the 30Q5 low flow or 7Q10 low flow*** as the critical receiving water flow when implementing ***nutrient criteria expressed as 30-day averages***.

Range of Possible Critical Receiving Water Flows
Based on State Water Quality Standards Dilution and Mixing Zone Policy

Flow Condition	Condition for Sparkling River Upstream of Anytown POTW Outfall 001*	If used in mass-balance equation when applying criteria for Shimmering Lake	If used in mass balance equation when applying criteria for Sparkling River
harmonic mean flow	640 cfs	640 cfs	320 cfs
30Q5 low flow	420 cfs	420 cfs	210 cfs
7Q10 low flow	300 cfs	300 cfs	150 cfs

*Based on USGS flow gauge data for Sparkling River, upstream of Anytown POTW Outfall 001 [NOTE: 1 MGD = 1.55 cfs]

Decision 3: Select a critical receiving water flow option for each criterion duration (averaging period) you are using. **If you did not use a particular criterion duration, choose "Not applicable" for the corresponding receiving water flow selection on the Answer Sheet for this portion of the exercise.**

Criterion Duration	Options for Critical Receiving Water Flow
Annual average	***Option 1:*** harmonic mean flow (100% when applying criteria for lake; 50% when applying criteria for river)
	Option 2: 30Q5 low flow (100% when applying criteria for lake; 50% when applying criteria for river)
	Option 3: Not applicable (not applying criteria as annual averages)
30-day average	***Option 1:*** 30Q5 low flow (100% when applying criteria for lake; 50% when applying criteria for river)
	Option 2: 7Q10 low flow (100% when applying criteria for lake; 50% when applying criteria for river)
	Option 3: Not applicable (not applying criteria as 30-day averages)

CRITICAL CONDITIONS—RECEIVING WATER (CONTINUED)

CRITICAL UPSTREAM RECEIVING WATER POLLUTANT CONCENTRATION (C_s IN MASS-BALANCE EQUATION)

Existing Policy

- The ***state policy for toxics and similar pollutants*** is to use the ***maximum observed upstream receiving water pollutant concentration*** as the critical upstream receiving water pollutant concentration.

Possible Adaptations for Nutrients

- The state has not determined how its existing policy will be adapted, if at all, for pollutants such as nutrients, which have longer duration components.
- ***One possible adaptation of the policy being considered for nutrients is to use the average upstream receiving water pollutant concentration***, rather than the maximum concentration, as the critical upstream receiving water concentration.

Receiving Water Pollutant Concentration Data—Sparkling River Upstream of Outfall 001 from State, EPA, and USGS Monitoring Studies

Parameter	Units	Average Concentration	Maximum Concentration	Number of Data Points
Phosphorus (total)	µg/L	8.0	15	12
Ammonia (NH_3) (as N)	mg/L	0.020	0.040	12
Total Kjeldahl Nitrogen (TKN)* (as N)	mg/L	0.060	0.080	12
Nitrate + Nitrite Nitrogen (as N)	mg/L	0.15	0.24	12

* organic nitrogen + ammonia

Decision 4: You have two options for determining the critical upstream receiving water pollutant concentration. Your selection is used in all calculations involving critical upstream pollutant concentrations. **Choose one critical receiving water pollutant concentration option and record your selection on the Answer Sheet for this portion of the exercise.**

Options for Critical Receiving Water Pollutant Concentration	
Option 1:	Maximum observed concentration (*state policy for toxic pollutants*) 15 µg/L for total phosphorus; 0.32 mg/L for total nitrogen
Option 2:	Average concentration 8.0 µg/L for total phosphorus; 0.21 mg/L for total nitrogen

CRITICAL CONDITIONS—EFFLUENT

CRITICAL EFFLUENT FLOW (Q_d IN MASS-BALANCE EQUATION)

Existing Policy

- The ***state policy for toxics and similar pollutants*** is to use the ***maximum daily effluent flow from the past five years*** as the critical effluent flow in water quality-based permitting calculations.

Possible Adaptations for Nutrients

- The state has not determined how it might adapt its existing policy for determining critical effluent flow to nutrients.
- ***Permit writers currently have flexibility to choose an appropriate critical effluent flow*** when permitting discharges of nutrients.

Measured Effluent Flow Values for Anytown POTW from Discharge Monitoring Reports (DMRs)

Outfall	Year	Maximum Daily Flow Rate	Design Flow Rate	Maximum Monthly Average Flow Rate	Long-Term Average Flow Rate
001	2013	30 MGD	28 MGD	24 MGD	20 MGD
	2012	29 MGD		23 MGD	
	2011	28 MGD		23 MGD	
	2010	26 MGD		22 MGD	
	2009	27 MGD		22 MGD	

Decision 5: You have four options for determining the critical effluent flow. Your selection is used in all calculations involving the critical effluent flow. **Choose one critical effluent flow option and record your selection on the Answer Sheet for this portion of the exercise.**

Options for Critical Effluent Flow	
Option 1:	Highest maximum daily flow rate from past 5 years (*state policy for toxic pollutants*) (30 MGD)
Option 2:	Design flow rate (28 MGD)
Option 3:	Maximum monthly average flow rate from the past 5 years (24 MGD)
Option 4:	Long-term average flow rate (20 MGD)

CRITICAL CONDITIONS—EFFLUENT (CONTINUED)

CRITICAL EFFLUENT POLLUTANT CONCENTRATION (C_d IN MASS-BALANCE EQUATION)

Existing Policy

- **Where there are < 10 data points available:** The ***state policy for toxics and similar pollutants*** is to use the equations in Chapter 3 of EPA's *Technical Support Document for Water Quality-based Toxics Control* (TSD) to ***estimate a 95th percentile upper bound of the daily effluent pollutant concentration at the 95% confidence level***.
- **Where there are ≥ 10 data points available:** The ***state policy for toxics and similar pollutants*** (which typically have durations of 1 hour or 4 days) is to ***directly calculate a 95th percentile upper bound of the daily effluent concentration*** based on the equations in Appendix E of EPA's TSD (see attachment).

Possible Adaptations for Nutrients

- The state is considering adapting its existing approach when addressing pollutants with longer duration components. Specifically, ***the state is considering using the 95th percentile upper bound of average weekly effluent pollutant concentrations (estimated or directly calculated)*** to use in the reasonable potential assessment ***for pollutants with criteria that have durations of ≥ 7 days***.
- The state has not adopted this alternative for criteria with durations of ≥ 7 days as statewide policy; however, some permit writers have used it in recent permits. Others continue to use the 95th percentile upper-bound of daily effluent concentrations as the critical effluent concentration for all pollutants.

Existing Effluent Data

- There were no effluent limitations for total nitrogen or total phosphorus in Anytown POTW's previous NPDES permit; however, the permit included effluent limitations and monitoring requirements for ammonia nitrogen and monitoring requirements for total phosphorus and for various forms of nitrogen. There are enough data points (60) for these parameters to calculate 95th percentile upper bound values.

Anytown POTW Outfall 001—Effluent Pollutant Concentration Data from Form 2A and DMRs

Parameter	Units	Maximum Daily Effluent Concentration	Daily Average Effluent Concentration $\hat{E}(X)$	CV_y	Number of Data Points
Phosphorus (total as P)	µg/L	3500	1300	0.6	60
Ammonia (NH_3) (as N)	mg/L	8.1	2.7	0.6	60
Total Kjeldahl Nitrogen (TKN)* (as N)	mg/L	11	4.4	0.5	60
Nitrate + Nitrite Nitrogen (as N)	mg/L	9.2	3.9	0.5	60

* organic nitrogen + ammonia

Decision 6: You have two options for calculating critical effluent pollutant concentrations from existing effluent data. Your selection is used in all calculations involving the critical effluent pollutant concentrations of total phosphorus and total nitrogen. **Choose one option for calculation of the critical effluent pollutant concentrations and record your selection on the Answer Sheet for this portion of the exercise.**

Options for Critical Effluent Pollutant Concentration (values rounded)	
Option 1:	95th percentile of daily values (*state policy for toxic pollutants*) Calculated as 2800 µg/L for total phosphorus; 16 mg/L for total nitrogen
Option 2:	95th percentile of weekly values Calculated as 1800 µg/L for total phosphorus; 11 mg/L for total nitrogen

PART 3: CALCULATE WQBELS

As noted previously, the state is using a steady-state approach to model the interaction of the effluent from Anytown POTW with the immediate receiving water (Sparkling River). In this exercise, we are using a mass-balance equation as our steady-state model. This equation is used to calculate concentration-based wasteload allocations (WLAs) that serve as the basis for WQBELs. The state has adapted the WQBEL calculation procedures in Chapter 5 of EPA's TSD to account for the range of potential WLA averaging periods and effluent limitation averaging periods that could be applied when developing WQBELs for nutrients.

To calculate WLAs:

$$\textbf{WLA} = C_d = \frac{(Q_r \times C_r) - (Q_s \times C_s)}{Q_d}$$

Where:

C_d = WLA (required effluent pollutant concentration)—*to be calculated*
Q_r = critical downstream receiving water flow
C_r = applicable water quality criterion
Q_s = critical upstream receiving water flow
C_s = critical upstream receiving water pollutant concentration
Q_d = critical effluent flow

- There is ***rapid and complete mixing*** of the effluent and receiving water, and the ***critical conditions used in the reasonable potential analysis in Part 2 are used in the WLA calculations*** as well.
- WLAs have the same averaging periods as the duration components of the criteria upon which they are based. These WLAs must be translated into WQBELs with the appropriate averaging periods.

WQBEL CALCULATION AND AVERAGING PERIODS

WQBEL calculation procedures are presented in the attachment to this exercise. Below is a discussion of options for WQBEL averaging periods.

Averaging Period(s) for WQBELs Derived from an Annual Average WLA (WLA_{annual})

- The state determined that conditions in Sparkling River and Shimmering Lake make using annual average annual limitations (AAL) to implement annual average nutrient criteria acceptable. In this case, state policy and procedures set the ***average annual limitation = WLA_{annual}***
- The state has developed procedures for calculating a maximum daily limitation (MDL), average weekly limitation (AWL), and average monthly limitation (AML) from the WLA_{annual}. These procedures assume that the ***WLA_{annual} = LTA*** (required long-term average concentration) and ***use the equations in EPA's TSD to calculate the MDL (99th percentile), AWL (95th percentile), and AML (95th percentile) from the LTA***.
- A ***monitoring frequency of 2 times per week*** will be used in the calculation of an AWL or AML.

Averaging Period(s) for WQBELs Derived from a 30-day Average WLA ($WLA_{30\text{-}day}$)

- The state has developed procedures for calculating a maximum daily limitation (MDL), average weekly limitation (AWL), and average monthly limitation (AML) from the $WLA_{30\text{-}day}$.
- These procedures assume that ***AML = $WLA_{30\text{-}day}$*** and ***use the equations in EPA's TSD to calculate the LTA (assuming $WLA_{30\text{-}day}$ is at the 99th percentile), MDL (99th percentile), and AWL (95th percentile)***.
- A ***monitoring frequency of 2 times per week*** will be used in the calculation of an AWL.

Decision 7: You have multiple options for expression of WQBELs calculated from annual average or 30-day average WLAs. **For each type of WLA, you may select more than one averaging period for effluent limitations that will be included in the permit.** You selections will apply to both total nitrogen and total phosphorus WQBELs. The more stringent of the limitations based on criteria for Sparkling River or Shimmering Lake will be the final WQBELs.

Choose the effluent limitation averaging period(s) that you will use to implement annual average nutrient criteria (if applicable) and 30-day average nutrient criteria (if applicable) and record your selections on the Answer Sheet for this portion of the exercise. You will be provided with the calculated WQBELs for each averaging period. These WQBELs are based on WLAs calculated using the critical conditions you selected in Part 2 of this exercise.

Remember, you may choose more than one WQBEL averaging period (i.e., more than one type of effluent limitation) for each type of WLA.

Options for WQBEL Averaging Periods	
WLA Averaging Period	**WQBEL Averaging Periods**
Annual average WLA	***Option 1:*** Average annual limitation (AAL)
	Option 2: Average monthly limitation (AML)
	Option 3: Average weekly limitation (AWL)
	Option 4: Maximum daily limitation (MDL)
	Option 5: Not applicable (not applying any criteria as annual averages)
30-day average WLA	***Option 1:*** Average monthly limitation (AML)
	Option 2: Average weekly limitation (AWL)
	Option 3: Maximum daily limitation (MDL)
	Option 4: Not applicable (not applying any criteria as 30-day averages)

Expression (Concentration/Mass) of Effluent Limitations to Protect Sparkling River and Shimmering Lake

- The state has not established a policy for how effluent limitations should be expressed (**concentration or mass or both**) to protect Sparkling River and Shimmering Lake.
- Numeric interpretations of narrative criteria are expressed in terms of concentration.
- Because of the nature of nutrient pollution and the presence of other sources contributing nutrient loading to Sparkling River and Shimmering Lake, mass loadings, especially to the Shimmering Lake, are a potential concern.

Decision 8: Determine whether to express the WQBELs in terms of concentration or mass or both.

Options for Expression of WQBELs	
Option 1:	Express WQBELs in terms of concentration only
Option 2:	Express WQBELs in terms of mass only
Option 3:	Express WQBELs in terms of both concentration and mass

PART 4: INCORPORATE ADDITIONAL PERMIT CONDITIONS AND IMPLEMENTATION TOOLS

As noted previously, the existing NPDES permit for Anytown POTW includes effluent limitations and monitoring requirements for ammonia nitrogen (to prevent aquatic toxicity) and monitoring requirements for TKN, nitrate+nitrite, and total phosphorus. The plant operates its existing treatment system to achieve some nitrogen and phosphorus removal, anticipating a potential future need to reduce its discharge of nutrients. Nitrogen and phosphorus requirements in the current permit are as follows:

Existing Permit Requirements		
Parameter	**Maximum Daily Limitation**	**Average Monthly Limitation**
Ammonia (NH_3) (as N)	9.0 mg/L	4.5 mg/L
Total Kjeldahl Nitrogen (TKN)* (as N)	Monitor Only	
Nitrate + Nitrite Nitrogen (as N)	Monitor Only	
Phosphorus (total as P)	Monitor Only	

* organic nitrogen + ammonia

Form 2A and DMRs from the previous five years provide the following phosphorus and nitrogen data for the discharge from Anytown POTW's Outfall 001. In addition, the 95th percentile effluent concentrations (daily or weekly average) were calculated to use when determining the need for WQBELs. The existing effluent concentration data are as follows:

Effluent Pollutant Concentration Data (Previous 5 Years) and 95th Percentile Projections						
Parameter	**Units**	**Maximum Daily Effluent Concentration (Observed)**	**Daily Average Effluent Concentration (Observed)**	**95th Percentile Daily Effluent Concentration (Projected)**	**95th Percentile Weekly Average Effluent Concentration (Projected)**	**Number of Data Points**
Phosphorus (total as P)	µg/L	3500	1300	2800	1800	60
Nitrogen (total as N)	mg/L	20	8.3	16	11	60

Anytown POTW has stated that it believes some modification of its existing treatment system and addition of economically feasible new treatment could yield the following monthly average effluent quality:

Anytown POTW Projected Average Effluent Quality			
Parameter	**Units**	**Modification of Existing Treatment System**	**Additional Treatment**
Phosphorus (total as P)	µg/L	1000	500
Nitrogen (total as N)	mg/L	8.0	5.0

As noted in the introduction, Anytown POTW discharges to Sparkling River at a point two (2) miles upstream of where the river enters Shimmering Lake. The simplified watershed diagram provided in the introduction shows several point sources and nonpoint sources upstream of Anytown POTW that discharge nutrients to Sparkling River or to one of its tributaries.

- Bigtown POTW is a well-funded POTW upstream of Anytown POTW on Sparkling River. It has decided to implement advanced treatment that will allow it to reliably treat to levels below its anticipated WQBELs. Currently, there are periodic nuisance algal blooms in Sparkling River downstream of Bigtown POTW.

- Other POTWs in the watershed, and most POTWs throughout the state, have not yet received reissued permits with WQBELs for nutrients. When they do, most are expected to indicate that they are in positions similar to that of Anytown POTW with regard to treatment capabilities and compliance.

- Fertilizers-R-Us is upstream of Anytown POTW on Sparkling River. This fertilizer plant has technology-based effluent limitations for total phosphorus and for various forms of nitrogen. Its permit is scheduled for reissuance next year and the state plans to determine the need for WQBELs in the Fertilizers-R-Us permit to protect water quality standards in Sparkling River and Shimmering Lake.

- Several farms upstream in the watershed received funding to implement best management practices (BMPs) for nutrient control selected from a menu of BMPs approved for funding. Those practices are in place and are achieving some reductions of total phosphorus and total nitrogen in runoff. State officials believe that additional BMPs selected from the menu might yield additional reductions.

Also as previously noted, Shimmering Lake is listed on the most recent Clean Water Act (CWA) section 303(d) list as impaired, with the cause listed as “nutrients.” Over the past two years, there have been periodic nuisance algal blooms and low dissolved oxygen levels in Shimmering Lake. Sparkling River is not included on the 303(d) list; however, there also have been periodic occurrences of nuisance algal blooms in Sparkling River over the past two years, indicating that it too is threatened by nutrient over-enrichment. A TMDL has not been completed for Shimmering Lake (and will not be completed for at least four years) and there has been no watershed study of existing nutrient concentrations or loadings or of the levels needed to ensure that water quality standards in Shimmering Lake or Sparkling River are maintained. Recall that the approach taken for the Anytown POTW permit was to calculate WQBELs based on attainment of an interpretation of narrative criteria and modeled using a steady-state approach.

Decision 9: You were provided with WQBELs calculated based on decisions you made regarding how to interpret nutrient criteria and the critical conditions you chose for water quality modeling. In addition, as described previously, Anytown POTW has indicated the effluent quality that it believes it can achieve with some modification of its current treatment and with additional, economically feasible treatment. Recall that the WQBELs were calculated based on critical conditions and a steady-state modeling approach and that there are no state policies currently in place regarding interpretation of nutrient criteria and their implementation in NPDES permits. The calculated WQBELs accounted for other sources of nutrient pollution to Sparkling River and Shimmering Lake only through consideration of critical receiving water background concentrations of total phosphorus and total nitrogen. **Answer the questions below regarding the WQBELs you calculated and your response to the information provided by Anytown POTW. Record your answers on the Answer Sheet for this portion of the exercise and be prepared to discuss them.**

Question 1:	Do you consider the levels of treatment that Anytown POTW indicates that it can economically achieve to be reasonable? Why or why not?
Question 2:	Currently, permit writers have considerable flexibility in how nutrient criteria may be interpreted, in the assumptions used in water quality models and to calculate WQBELs, and in WQBEL averaging periods. Do you think it is appropriate to reconsider any of your assumptions in light of the information on economically feasible treatment capabilities provided by Anytown POTW? Why or why not?

Decision 10: The NPDES regulations require that permits must specify the type, intervals, and frequency of monitoring sufficient to yield data representative of the monitored activity [40 CFR 122.48(b)]. ***Recall that a monitoring frequency of 2 times per week was used to calculate any average weekly limitation or average monthly limitation in Part 3.*** Reporting requirements must be established on a case-by-case basis with the frequency dependent on the nature and effect of the discharge, but in no case less than once a year [40 CFR 122.44(i)(2)]. In addition to regular effluent monitoring and reporting, the special conditions section of the permit may include other monitoring and reporting requirements or requirements to conduct a special study related to nutrients.

Answer the questions below regarding monitoring and reporting requirements and related special conditions that you might include in the Anytown POTW permit. Record your answers on the Answer Sheet for this portion of the exercise and be prepared to discuss them.

Question 1:	Do you think the two (2) times per week monitoring frequency for limited nutrients that was used in the WQBEL calculations (see Part 3) is appropriate? If not, how would you adjust the required monitoring frequency?
Question 2:	With what frequency will you require reporting of total phosphorus and total nitrogen effluent concentrations and/or mass loading?
Question 3:	Are there any other monitoring and reporting or study requirements related to nutrients (e.g., monitoring non-limited nutrients, ambient monitoring) that you will include in the Anytown POTW permit and, if so, what are they? Given the other sources of nutrient pollution in the watershed, do any of these additional requirements lend themselves to a monitoring consortium or other watershed-based approach?

Decision 11: The state's permitting regulations and water quality standards provide tools, such as permit compliance schedules and water quality standards variances, that would allow for flexibility in implementing water quality standards or achieving compliance with WQBELs in NPDES permits. Regarding some other tools that could prove useful for nutrient permitting (e.g., water quality trading), state law and policy are silent.

- State water quality standards generally allow compliance schedules for WQBELs in NPDES permits.
- State water quality standards allow water quality standards variances, though the state has very little experience with adopting water quality standards variances and completing the EPA approval process.
- The state does not have specific legislation or regulations authorizing and providing the structure for a statewide trading program or a watershed-based permitting program.

Review the potential tools for flexibility below and determine which, if any, you will consider as part of an implementation strategy for the Anytown POTW permit or that you would wish your state agency to consider as part of a broader strategy for nutrient criteria implementation in the state. Keep in mind that some options might require a significant investment of the permitting authority's resources. Record your answers on the Answer Sheet for this portion of the exercise and be prepared to discuss them.

***You may select more than one option*.**

Option 1:	Incorporate a compliance schedule into Anytown POTW's NPDES permit to provide time to come into compliance with final WQBELs. If you choose this option, indicate the proposed compliance schedule length and the underlying basis for any interim effluent limitations for total phosphorus and total nitrogen that will be included in the permit.
Option 2:	Recommend considering an individual discharger variance for Anytown POTW. If you choose this option, indicate the underlying basis for calculating WQBELs (if any) for total phosphorus and total nitrogen during the time the variance would be in place.
Option 3:	Recommend developing a statewide, multi-discharger variance procedure that will allow Anytown POTW and other POTWs throughout the state to obtain a variance from water quality standards requirements for nutrients. If you choose this option, indicate the underlying basis for calculating WQBELs (if any) for total phosphorus and total nitrogen during the time the variance is in place.
Option 4:	Recommend accelerating TMDL development (for Shimmering Lake) or conducting a watershed modeling study in advance of the TMDL to account for the effects of nutrient loadings from sources throughout the watershed on attainment of water quality criteria. As appropriate, modify the Anytown POTW permit based on the results of the study.
Option 5:	Incorporate special conditions within the Anytown POTW permit that would allow it to enter into a water quality trading agreement. If you choose this option, indicate whether Anytown POTW would be permitted to trade with point sources, nonpoint sources, or both.
Option 6:	Recommend establishing a statewide nutrient trading program to address Anytown POTW and other facilities likely to receive WQBELs for nutrients below the levels to which they believe they are able to provide economically feasible treatment. If you choose this option, indicate whether the program would facilitate trading among point sources, between point sources and nonpoint sources, or both.
Option 7:	Do not provide or recommend any tools for flexibility in this permit. Explain why you chose this option.

ATTACHMENT

REASONABLE POTENTIAL ANALYSIS CRITICAL EFFLUENT CONCENTRATION AND WQBEL CALCULATION PROCEDURES

This Attachment provides the procedures used to calculate the critical effluent concentrations used in this exercise for the reasonable potential analysis and the procedures used to calculate WQBELs from wasteload allocations for the Anytown POTW permit.

REASONABLE POTENTIAL ANALYSIS: CRITICAL EFFLUENT POLLUTANT CONCENTRATION (C_d IN MASS-BALANCE EQUATION)

Calculation of the 95th percentile upper bound effluent pollutant concentration based on the equations in Appendix E of EPA's *Technical Support Document for Water Quality-based Toxics Control* (TSD) is as follows:

C_d = 95th percentile = $\hat{E}(X) \times \exp[Z_{0.95}\,\hat{\sigma}_n - 0.5\,\hat{\sigma}_n^2]$ (assumes all quantified values)

Where:

C_d = critical effluent pollutant concentration—*to be calculated*
$\hat{E}(X)$ = daily average concentration
$Z_{0.95}$ = 1.645 (for 95th percentile)
$\hat{\sigma}_n^2$ = $\ln[(CV_y^2/n) + 1]$
CV_y = coefficient of variation of log-transformed individual measurements
n = days in averaging period of concern (e.g., n = 1 for daily, n = 7 for weekly average)

WQBELs Derived from an Annual Average WLA (WLA_{annual}) and Criterion

- **Average annual limitation (AAL) = WLA_{annual}**
- To calculate **AML, AWL, MDL**
- Set **WLA_{annual} = LTA** (required long-term average concentration)
- **Use the LTA and the equation in EPA's TSD**

AML | AWL | MDL = LTA × $\exp[Z_p\sigma_n - 0.5\sigma_n^2]$

Where:

Z_p = the z statistic at the pth percentile
For calculating the AML or AWL, use the z statistic at the 95th percentile (1.645)
For calculating the MDL, use the z statistic at the 99th percentile (2.326)
σ_n^2 = $\ln[(CV_y^2/n) + 1]$
CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data
n = # of daily samples averaged over the averaging period for the effluent limitation (e.g., # of samples per month for the AML; # of samples per week for the AWL)

To calculate

- **Average monthly limitation (AML)** (limit set at 95th percentile)
  $AWL = LTA \times \exp[Z_{0.95}\sigma_n - 0.5\sigma_n^2]$

  Where:
  $Z_{0.95}$ = the z statistic at the 95th percentile (1.645)
  σ_n^2 = $\ln[(CV_y^2/n) + 1]$
  CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data
  n = monthly monitoring frequency (# of daily samples to be averaged per month) = 8

- **Average weekly limitation (AWL)** (limit set at 95th percentile)
  $AWL = LTA \times \exp[Z_{0.95}\sigma_n - 0.5\sigma_n^2]$

  Where:
  $Z_{0.95}$ = the z statistic at the 95th percentile (1.645)
  σ_n^2 = $\ln[(CV_y^2/n) + 1]$
  CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data
  n = weekly monitoring frequency (# of daily samples to be averaged per week) = 2

- **Maximum daily limitation (MDL)** (limit set at 99th percentile; n = 1 for the MDL)
  $MDL = LTA \times \exp[Z_{0.99}\sigma - 0.5\sigma^2]$

  Where:
  Z_{99} = the z statistic at the 99th percentile (2.326)
  σ^2 = $\ln[CV_y^2 + 1]$
  CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data

Calculations in the exercise assumed a **monitoring frequency of 2 times per week** when calculating the AWL and AML (i.e., n = 8 for AML; n = 2 for AWL)

WQBELs Derived from a 30-day Average WLA ($WLA_{30\text{-}day}$) and Criterion

- **Average monthly limitation (AML) = $WLA_{30\text{-}day}$**

  - To calculate **LTA (required long-term average)**, use the $WLA_{30\text{-}day}$ (set at the 99th percentile on the lognormal distribution) and the equations in EPA's TSD

    $LTA = WLA_{30\text{-}day} \times \exp[0.5\sigma_{30}^2 - Z_{0.99}\sigma_{30}]$

    Where:
    $Z_{0.99}$ = the z-statistic at the 99th percentile (2.326)
    σ_{30}^2 = $\ln[(CV_y^2/30) + 1]$ (used for calculating a long-term average from a 30-day wasteload allocation)
    CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data

- **Use the LTA and the equation in EPA's TSD**

  $AWL \mid MDL = LTA \times \exp[Z_p\sigma_n - 0.5\sigma_n^2]$

To calculate

- **Average weekly limitation (AWL)** (limit set at 95th percentile)
  $AWL = LTA \times \exp[Z_{95}\,\sigma_n - 0.5\,\sigma_n^2]$

  Where:
  $Z_{0.95}$ = the z-statistic at the 95th percentile (1.645)
  σ_n^2 = $\ln[(CV_y^{\,2}/n) + 1]$
  CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data
  n = weekly monitoring frequency (# of daily samples to be averaged per week) = 2

- **Maximum daily limitation (MDL)** (limit set at 99th percentile; n = 1 for the MDL)
  $MDL = LTA \times \exp[Z_{99}\,\sigma_n - 0.5\,\sigma_n^2]$

  Where:
  $Z_{0.99}$ = the z-statistic at the 99th percentile (2.326)
  σ^2 = $\ln[CV_y^{\,2} + 1]$
  CV_y = coefficient of variation of log-transformed individual measurements from existing effluent data

Calculations assumed a **monitoring frequency of 2 times per week** when calculating the AWL.

Mass Effluent Limitations

- To calculate mass WQBELs from concentration WQBELs

  $WQBEL_{mass}$ (in lbs/day) = $WQBEL_{concentration}$ (in mg/L) x Q_d x 8.34

  Where:
  Q_d = critical effluent flow in MGD (million gallons per day)

Note:

- 1 mg/l = (1 part/million parts) = (1 gallon by weight/1,000,000 gallons) = 8.34 lbs/million gallons
- Providing a conversion factor of: 8.34 (lbs/million gallons)/ 1 (mg/L)
- Therefore: [Flow (MGD)]*[Concentration (mg/l)]*[8.34 (lbs/MG)/1 (mg/l)] = Load (lbs/day)