



# DURATION AND FREQUENCY: HOW DOES IT IMPACT NPDES PERMITTING DECISIONS?

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ACWA NUTRIENTS WORKSHOP: NOV. 5-7



Steps to  
Determine the  
Need for  
WQBELs

- **Step 1—Determine Whether to Conduct Qualitative or Quantitative Reasonable Potential Analysis**
- **Step 2—Interpret Nutrient Criteria for Quantitative Reasonable Potential Analysis**
- **Step 3—Select Water Quality Model for Quantitative Reasonable Potential Analysis**
- **Step 4—Select Model Conditions and Conduct Quantitative Reasonable Potential Analysis**

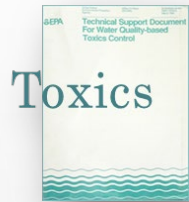
# STEADY-STATE MODELING—CRITICAL CONDITIONS

- **CRITICAL CONDITIONS** ARE SELECTED FOR A STEADY-STATE MODEL SO THAT IF WATER QUALITY STANDARDS ARE ATTAINED UNDER SUCH CONDITIONS, THEY SHOULD BE ATTAINED UNDER OTHER FORESEEABLE CONDITIONS
- STATES SHOULD HAVE, OR SHOULD DEVELOP, **POLICIES AND PROCEDURES FOR DETERMINING CRITICAL CONDITIONS** FOR STEADY-STATE MODELING
- EXISTING POLICIES AND PROCEDURES FOR DETERMINING CRITICAL CONDITIONS FOR COULD BE **ADAPTED, AS NEEDED, TO ADDRESS NUTRIENTS**

# STEADY-STATE MODELING—CRITICAL CONDITIONS

- CRITICAL CONDITIONS FOR MODELING:
  - RECEIVING WATER FLOW AND POLLUTANT CONCENTRATION
  - EFFLUENT FLOW AND POLLUTANT CONCENTRATION
  - OTHER CONDITIONS AFFECTING NUTRIENT CONCENTRATIONS OR RESPONSE VARIABLES IN THE RECEIVING WATER OR DOWNSTREAM WATER BODY OF CONCERN (E.G., TEMPERATURE, SOLAR RADIATION)
- SELECT VALUES FOR CRITICAL CONDITIONS THAT CORRESPOND TO THE DURATION AND FREQUENCY COMPONENTS OF THE WATER QUALITY CRITERIA

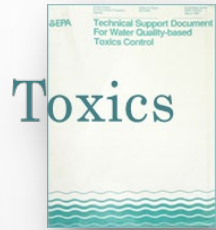
# CRITICAL RECEIVING WATER FLOW



TN TP

- RIVERS AND STREAMS HAVE HIGHEST PROBABILITY OF EFFECTS DURING **LOW-FLOW CONDITIONS**
- CRITICAL FLOWS OFTEN PROVIDED IN **WATER QUALITY STANDARDS**
- CRITICAL FLOWS SHOULD **REFLECT DURATION AND FREQUENCY** COMPONENTS OF CRITERIA.
- EXAMPLES:
  - 1Q10 OR 1B3 (ACUTE)
  - 7Q10 OR 4B3 (CHRONIC)
  - HARMONIC MEAN (HUMAN HEALTH)
- RIVERS AND STREAMS HAVE HIGHEST PROBABILITY OF SECONDARY EFFECTS FROM EXCESS NUTRIENTS DURING **LOW-FLOW CONDITIONS**
- CRITICAL RECEIVING WATER FLOWS SHOULD **REFLECT DURATION AND FREQUENCY** COMPONENTS OF CRITERIA.
  - HYDROLOGICALLY-BASED FLOWS (7Q10, 30Q5, HARMONIC MEAN)
  - BIOLOGICALLY-BASED FLOWS MATCHING DURATION AND FREQUENCY

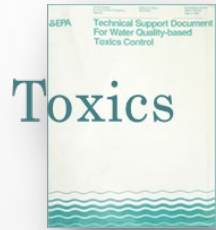
# CRITICAL EFFLUENT FLOW



TN TP

- **NO SPECIFIC GUIDANCE** IN TSD
- **MEASURE OF MAXIMUM FLOW** (E.G., MAXIMUM DAILY, MAXIMUM MONTHLY AVERAGE)
- **EXISTING POLICIES OR PROCEDURES** SHOULD ADDRESS THIS CRITICAL CONDITION
- **USE FLOW DATA** FROM DMRS, PERMIT APPLICATIONS, FACILITY STUDIES
- **Use existing policies** or procedures for other pollutants
- Could **adapt procedures for some nutrient criteria** based on duration (e.g., seasonal or annual average criteria)

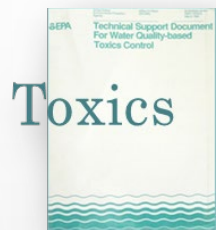
# CRITICAL RECEIVING WATER POLLUTANT CONCENTRATION



TN TP

- **NO SPECIFIC GUIDANCE** IN TSD
- **MEASURE OF MAXIMUM CONCENTRATION** (E.G., MAXIMUM OBSERVED, 95<sup>TH</sup> PERCENTILE) OUTSIDE INFLUENCE OF DISCHARGE
- **EXISTING POLICIES OR PROCEDURES** SHOULD ADDRESS THIS CRITICAL CONDITION
- **USE POLLUTANT DATA** FROM STORET, USGS, STATE SOURCES, FACILITY STUDIES, ETC.
- **Use existing policies** or procedures for other pollutants
- Could **adapt procedures for some nutrient criteria** based on duration (e.g., seasonal or annual average criteria)

# CRITICAL EFFLUENT POLLUTANT CONCENTRATION



TN TP

- ASSUME EFFLUENT DATA ARE **LOGNORMAL**  
(UNLESS SHOWN OTHERWISE)
- USE STATISTICS AND EXISTING DATA TO ESTIMATE A **SINGLE UPPER-BOUND EFFLUENT POLLUTANT CONCENTRATION** (E.G., 95<sup>TH</sup> OR 99<sup>TH</sup> PERCENTILE)
- **EXISTING POLICIES OR PROCEDURES** SHOULD ADDRESS THIS CRITICAL CONDITION
- ASSUME EFFLUENT DATA ARE **LOGNORMAL**  
(UNLESS SHOWN OTHERWISE)
- COULD USE STATISTICS AND EXISTING DATA TO ESTIMATE **DIFFERENT CRITICAL EFFLUENT POLLUTANT CONCENTRATIONS TO USE WITH DIFFERENT CRITERIA DURATIONS**
- **TSD PROCEDURES CAN BE ADAPTED** TO APPLY THIS APPROACH



# CRITICAL EFFLUENT POLLUTANT CONCENTRATION: SANDPOINT POTW – PEND OREILLE RIVER, IDAHO



Lake Pend Oreille, Idaho  
(Lake Pend Oreille Basin Commission, 2013)

- EPA REGION 10 REVIEWED TP CONCENTRATIONS REPORTED ON DMRS SUBMITTED BY SANDPOINT BETWEEN MARCH 2002 AND MARCH 2012
- THE REGION ELECTED NOT TO USE AN ESTIMATE OF THE UPPER-BOUND TP CONCENTRATION
- REGION 10 DETERMINED THAT THE **AVERAGE TOTAL PHOSPHORUS EFFLUENT CONCENTRATION OF 2.41 MG/L** WAS AN APPROPRIATE MEASURE OF THE CRITICAL EFFLUENT CONCENTRATION WHEN CONSIDERING ATTAINMENT OF AN ANNUAL AVERAGE CRITERION

# EXAMPLE STATISTICAL PROCEDURE FOR ESTIMATING CRITICAL EFFLUENT POLLUTANT CONCENTRATION

Duration of Numeric Criteria or Numeric Interpretations of Narrative	Critical effluent pollutant concentration: 95 <sup>th</sup> percentile of projected population of...
< 7 days	Daily effluent pollutant concentration measurements
7-30 days	Weekly average effluent pollutant concentration measurements
> 30 days	Monthly average effluent pollutant concentration measurements

$$95^{\text{th}} \text{ percentile} = \hat{E}(X) \times e^{[z_{0.95} \hat{\sigma}_n - 0.5 \hat{\sigma}_n^2]}$$

**Steps to  
Calculate  
Water Quality  
based Effluent  
Limitations**

- **Step 1—Determine Wasteload Allocations**
- **Step 2—Calculate Water Quality-based Effluent Limitations**
- **Step 3—Evaluate the Need for Concentration and Mass Limits**

## STEP 2—CALCULATE WQBELS

§ 122.45(D) REQUIRES THAT EFFLUENT LIMITATIONS FOR CONTINUOUS DISCHARGES, **UNLESS IMPRACTICABLE**, BE EXPRESSED AS

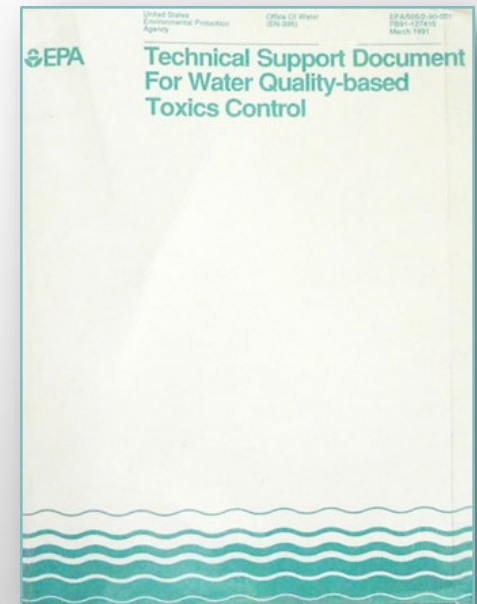
- POTWS
  - AVERAGE MONTHLY LIMITATIONS (AMLS)
  - AVERAGE WEEKLY LIMITATIONS (AWLS)
- NON-POTWS
  - AVERAGE MONTHLY LIMITATIONS (AMLS)
  - MAXIMUM DAILY LIMITATIONS (MDLS)

# WQBEL AVERAGING PERIODS

- EPA HAS ACKNOWLEDGED THAT THE LIMITATION EXPRESSIONS IN § 122.45(D) MIGHT NOT BE PRACTICABLE FOR ALL TYPES OF POLLUTANTS
- **EXAMPLE:** PER THE TSD, IN BOTH NON-POTW AND POTW PERMITS, WQBELS FOR TOXIC POLLUTANTS SHOULD BE EXPRESSED AS
  - AVERAGE MONTHLY LIMITATIONS (AML)
  - MAXIMUM DAILY LIMITATIONS (MDL)

# WQBELS FOR NUTRIENTS CRITERIA WITH DURATION $\leq 30$ DAYS

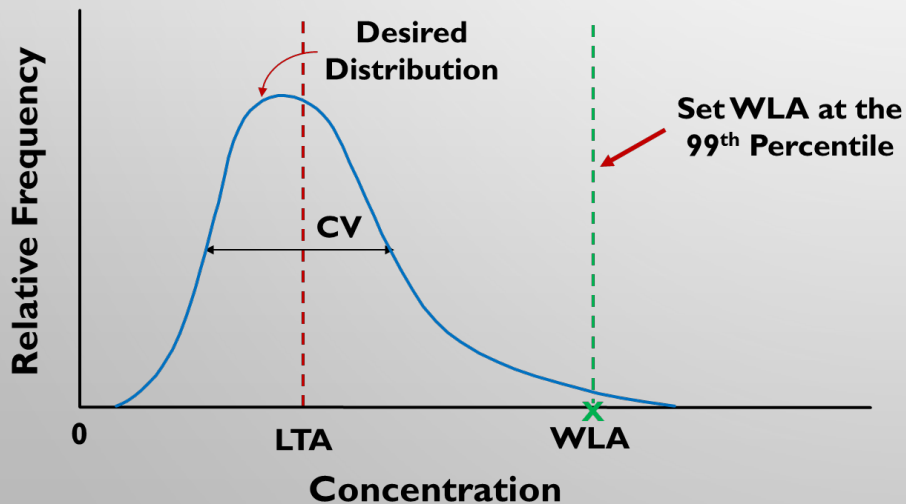
- TSD PROVIDES AN APPROACH TO CALCULATING AN AML AND AN MDL FOR CRITERIA WITH DURATIONS  $\leq 30$  DAYS
- THIS APPROACH COULD BE ADAPTED TO CALCULATE WQBELS FOR NUTRIENTS



# ADAPTATIONS FOR NUTRIENTS

TN  
TP

- FOR NUTRIENTS THERE MIGHT BE ONLY A SINGLE CRITERION WITH A DURATION OF  $\leq 30$  DAYS (OR NO SUCH CRITERION)
- THUS, THERE MIGHT BE ONLY A SINGLE LTA CALCULATION **LTA = WLA X E**  
 $[0.5\Sigma_N^2 - Z\Sigma_N]$
- COULD CALCULATE WQBELS FROM THIS SINGLE LTA



Calculate long-term average (LTA) for each WLA



# ANNUAL OR SEASONAL NUTRIENT CONCENTRATION OR LOADING CONCERNS

TN  
TP

- NUMERIC NUTRIENT CRITERIA OR NUMERIC INTERPRETATIONS OF NARRATIVE CRITERIA MIGHT BE EXPRESSED AS ANNUAL OR SEASONAL AVERAGES
  - WLAS FROM WATER QUALITY MODELS CONSIDERING ATTAINMENT OF ANNUAL OR SEASONAL AVERAGE CRITERIA WOULD BE EXPRESSED AS  $WLA_{(ANNUAL)}$  OR  $WLA_{(SEASONAL)}$
- IN ADDITION, RESPONSES (OR RESPONSE VARIABLE CRITERIA) IN SOME WATER BODIES COULD BE MOST SENSITIVE TO ANNUAL OR SEASONAL NUTRIENT LOADINGS



# CHESAPEAKE BAY MEMO<sup>TN</sup> TP

- LONG-TERM NATURE OF NUTRIENT IMPACTS IN THE CHESAPEAKE BAY WATERSHED (ESPECIALLY IN DOWNSTREAM WATERS) LED TO DISCUSSION OF ANNUAL EFFLUENT LIMITATIONS FOR NUTRIENTS
- EPA MEMORANDUM (2004) CONCLUDED THAT IT WAS IMPRACTICABLE TO EXPRESS EFFLUENT LIMITATIONS DEVELOPED TO ADDRESS CERTAIN NUTRIENT-RELATED CRITERIA IN THE CHESAPEAKE BAY AS AMLS, AWLS, AND MDLS
- EPA RECOGNIZED THAT PRINCIPLES IN THE MEMO MIGHT BE APPROPRIATELY APPLIED TO NUTRIENT PERMITTING OUTSIDE OF THE BAY
- APPROPRIATENESS OF SUCH APPLICATIONS OUTSIDE THE CHESAPEAKE BAY WATERSHED WOULD NEED TO BE DEMONSTRATED

# DEMONSTRATING THE ADEQUACY OF ANNUAL WQBELS



- EXPOSURE PERIOD OF CONCERN IS VERY LONG
- AREA OF CONCERN IS FAR-FIELD
- AVERAGE, RATHER THAN MAXIMUM, POLLUTANT LOAD OR CONCENTRATION IS OF CONCERN (BIOLOGICAL AND PHYSICAL PROCESSES “INTEGRATE” NUTRIENT LOADS OVER TIME)
- ANNUAL LIMITATIONS ARE TECHNICALLY SUPPORTABLE WITH ROBUST DATA AND MODELING
- APPROPRIATE SAFEGUARDS TO PROTECT ALL OTHER APPLICABLE WATER QUALITY STANDARDS (E.G., LOCAL WATER BODY STANDARDS) ARE EMPLOYED

# APPLICATION OF CHESAPEAKE BAY MEMO

ANNUAL AVERAGE (OR SEASONAL AVERAGE) WQBELS MIGHT BE APPROPRIATE WHEN IMPLEMENTING:

- **RESPONSE VARIABLE CRITERIA** (E.G., DO, CHLOROPHYLL A) IN DOWNSTREAM WATERS **WHEN IT IS DEMONSTRATED** THAT ANNUAL AVERAGE (OR SEASONAL AVERAGE) NUTRIENT WQBELS ARE ADEQUATE TO ENSURE CRITERIA ARE MET (E.G., EPA REGION 10'S IDAHO POTW PERMIT LIMITS TO PROTECT LAKE SPOKANE)
- **ANNUAL AVERAGE (OR SEASONAL AVERAGE) CRITERIA** FOR NUTRIENTS OR AN INTERPRETATION OF NARRATIVE CRITERIA THAT USES ANNUAL (OR SEASONAL) NUTRIENT TARGETS

# SUMMARY

- THE DURATION AND FREQUENCY COMPONENTS OF CRITERIA ARE IMPORTANT TO A PERMIT WRITER WHEN THEY DETERMINE REASONABLE POTENTIAL AND CALCULATE WQBELS
- TSD PROCEDURES MAY BE USED FOR ANY DURATION UNDER 30 DAYS
- DURATION'S OVER 30 DAYS WILL NEED TO MODIFY TSD PROCEDURES
  - CRITICAL CONDITION CONSIDERATIONS MAY CHANGE
  - WLA TO LTA CALCULATIONS
  - MAY BE "IMPRACTICABLE" TO CALCULATE PERMIT AVERAGING PERIODS UNDER § 122.45(D).
- WITHOUT EXPLICIT DURATION COMPONENT OF CRITERIA, PERMIT WRITER IS LEFT TO MAKE ASSUMPTIONS ABOUT APPROPRIATE DURATION IN ORDER TO DEVELOP PERMIT LIMITS.