Flow for Nutrient Permitting (continued)

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NHDES Watershed Management Bureau
July 25, 2019 WQSAC Meeting

Topics for Today

A. Background
B. Alternative Flows
C. Ambient TP Target(s)
D. Framework for Permit Guidance (Initial Discussion)

A. BACKGROUND

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A.1 Existing Rules

- Env-Wq 1705.02 required use of 7Q10 flow for calculating permit limits for all aquatic life criteria
  - "7Q10" means the lowest average flow that occurs for 7 consecutive days on an annual basis with a recurrence interval of once in 10 years on average, expressed in terms of volume per time period (Env-Wq 1702.01)
- Aquatic life criteria include nutrients [e.g., total phosphorus (TP) and total nitrogen (TN)]
- Nutrient criteria are narrative, not numeric (Env-Wq 1703.14)

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A.2 Changes to Statute

- In 2017 the statute was changed to prohibit NHDES from using 7Q10 (or lower flows) for calculating nutrient permit limits
  - (RSA 485-A:8, II - "*The commissioner shall not calculate nutrient discharge limits for aquatic life and human health criteria based on 7Q10 flow or such other flow criteria more restrictive than 7Q10*."
- Why? According to Rochester and Great Bay Municipal Coalition: "The 7Q10 was derived for toxics permitting and is inconsistent with the frequency/duration elements of nutrient-related impacts in streams" and some other states use higher flows for nutrient permitting (examples are given). (9/2/16 letter from Brown and Coldwell to NHDES Commissioner).
- Statue has precedent over rule

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A.3 Why nutrients are a concern (with focus on TP)

- Focus on TP because:
  - Most NH WWTFs discharge directly to fresh surface waters
  - TP is usually the "limiting" nutrient controlling plant growth in freshwater systems.
- TP is not toxic, however excess TP can lead to undesirable responses such as:
  - unsightly algal blooms,
  - cyanobacteria outbreaks
  - violations of dissolved oxygen and/or pH criteria
  - adverse impacts on the benthic community
  - other

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A.4 Factors influencing how a waterbody responds to a TP load

- Magnitude, location and timing of loadings
- Form of nutrient (dissolved more readily bioavailable)
- Flushing rate/residence time
- Water clarity / Light (plants need light to grow)
- Temperature (affects growth rates)
- Remaining Assimilative Capacity (RAC) for response parameters such as DO, pH, chlorophyll a, etc.
  - If a waterbody has little remaining AC, it will not be able to handle as much TP as a healthier system.

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A.5.1 EPA Default Methodology

- Discussed EPA default methodology for calculating NPDES WWTF permit limits when site specific criteria (per Env-Wq 1704) or studies such as TMDLs are not available.
  - Uses mass balance equation for determining if there is reasonable potential (RP) to exceed downstream TP target, as well as TP permit limits (if there is RP).
  - Calculations currently assume:
    - Upstream river flow = 7Q10
    - WWTF Flow = Design Flow
    - Downstream TP target = 90 ug/L [equal to 100 ug/L (from EPA Gold Book) multiplied by 0.9 to reserve 10% of the Assimilative Capacity (AC) per Env-Wq 1705.01(a)].
  - Per EPA:
    - If flows higher than 7Q10 are used, then downstream target is likely to be lower than 100 ug/L (x 0.9 to reserve 10% AC)
    - Facilities with existing TP permit limits cannot have less stringent limits due to federal "anti-backsliding" regulations.
    - NPDES is a preventative program; limits must comply with EPA approved State Water Quality Standards (WQS).

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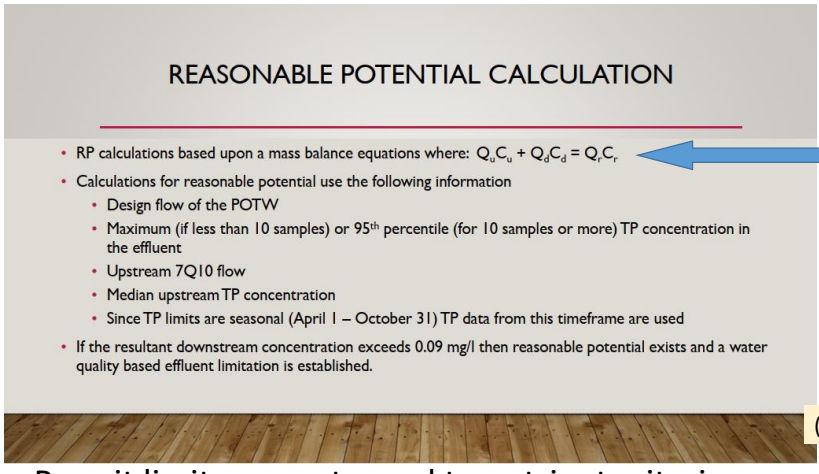
A.5.2 EPA Default Methodology (cont.)



Mass Balance Equation

(Jan. 11, 2018 – EPA R1)

Permit limits are not equal to nutrient criteria.

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A.6 EPA Letter of 7/3/19

- States must submit water quality standard (WQS) revisions to EPA for approval [40 CFR 131.5 (a)].
- If EPA does not approve a State WQS, they can promulgate (40 CFR 131.22)
- EPA uses EPA approved State WQSs in NPDES permits.
- 1/30/18 – NHDES requested EPA approval of amendments to State statutes regarding WQS revisions to river flow for nutrient permitting (and dissolved oxygen):
- 7/3/19 EPA reply:
  - Although NHDES' justification ("nutrients as opposed to toxics, do not create the type of short-term impacts that require use of the "worst case" scenario") is helpful, "NHDES has not provided the scientific basis demonstrating that elimination of the 7Q10 flow for nutrient permitting would be protective of designated uses" and requested that NHDES submit the scientific rationale for this revision.
- We need to address EPA's letter of 7/3/19
  - No deadline given by EPA

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A.7 Our Charge

- Determine alternative flow that is greater than the 7Q10 for nutrient permitting (our original charge)
- Determine appropriate ambient TP target(s) for nutrient permitting since waterbody response to nutrients is dependent on TP load (as well as other factors – see A.4)
- Develop guidance to assist permit writers and permittees
- Address EPA's letter of 7/3/19 (see A.6)
  - No deadline given by EPA

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B. ALTERNATIVE FLOWS

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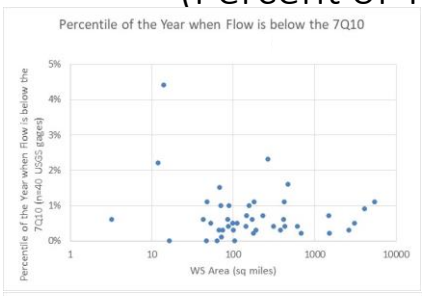
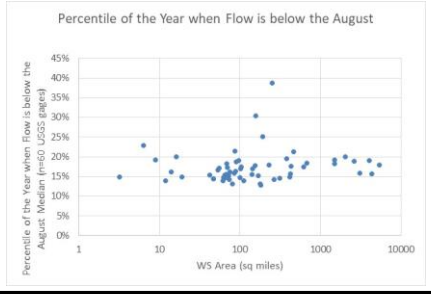
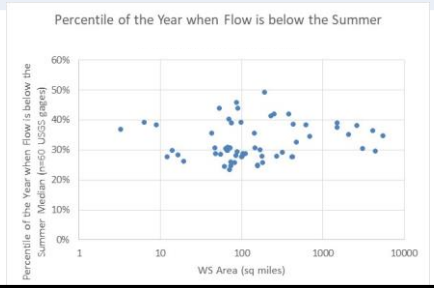
B.1 Flow Comparison- Frequency (Percent of Time Flow is Less)



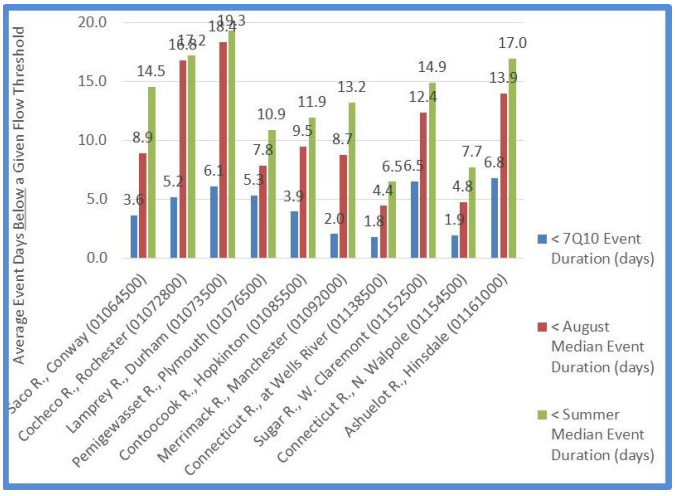


Flow	Number of USGS Gages	Median Percent of Time flow is less [1]
7Q10	42	0.5%
August Median	62	16.2%
Summer Median (May 1-Sept 30)	62	30.2%

1. Percent of Time is based on approximately 30 years of record

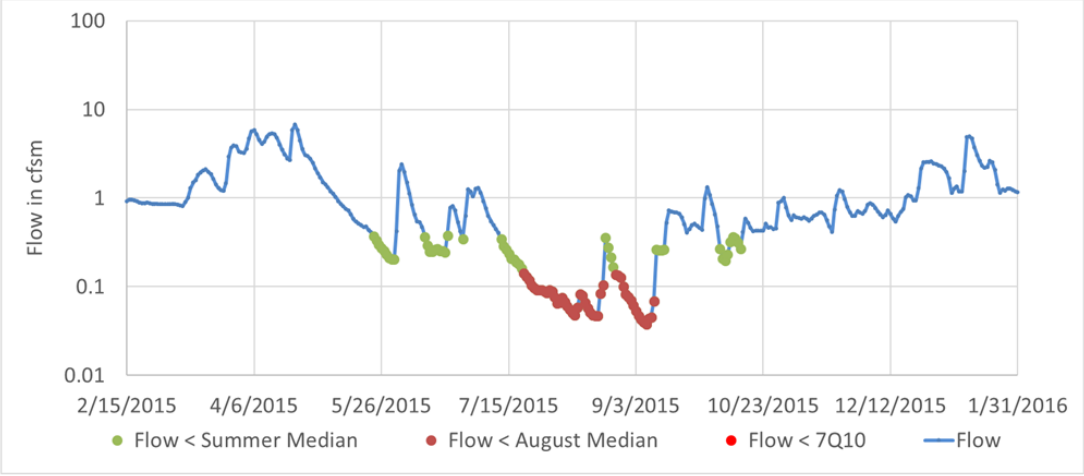


B.2 Flow Comparison- Duration (Average No. of Consecutive Days When Flow is Less)



Flow	Range and (median) of Average No. of Consecutive Days When Flow is Less (Based on 10 USGS Gages with most having ~ 30 years of record)
7Q10	1.9-6.8 (median = 4.5)
August Median	4.4 – 18.4 (median = 9.2)
Summer Median	6.5 - 19.3 (median = 13.9)

B.3 Flow Comparison- Example Hydrograph for Lamprey River Gage (01073500) showing Days when Flow is Less



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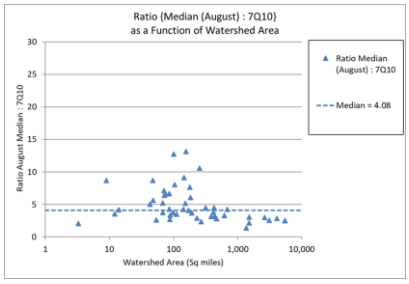
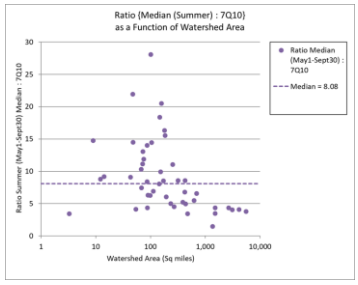
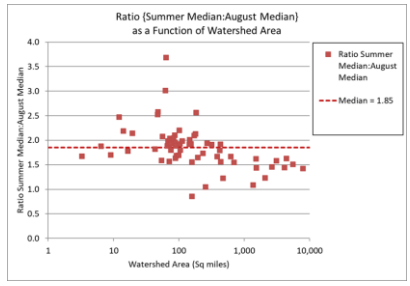
B.4 Flow Comparison- Ratios (as a Function of Watershed Area)







Flows	Median Ratio*	No. of USGS Gages
August Median / 7Q10	4.08	42
Summer Median / 7Q10	8.08	42
Summer Median/August Median	1.85	62

* Ratios are quite variable

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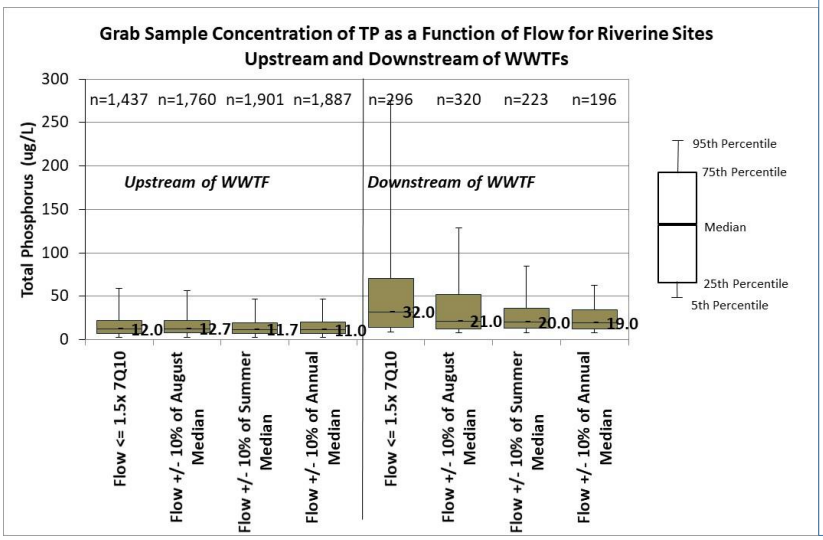
B.5 Flow Comparison - Ambient Concentrations Downstream of WWTFs



Median Ambient TP <u>without upstream WWTFS</u> is about 11-13 ug/L regardless of flow

Median Ambient TP <u>downstream of WWTFs</u> almost doubles when flows are ≥ August Median (19-21 ug/L) and almost triples (32 ug/L) when flows are near 7Q10

Shows WWTFs impact on ambient TP increases as flow decreases (drier weather) and becomes more apparent around August Median

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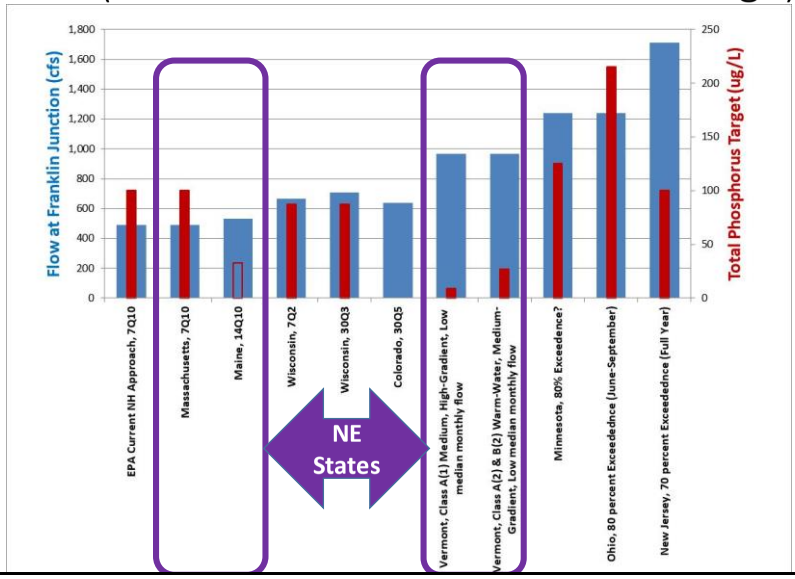
B.6 Flow Comparison - With Other NE States (Based on Flow at Franklin NH Gage)



NE State	Flow Currently Used for Nutrient Permitting
NH	7Q10
MA	7Q10
VT	Low Median Monthly Flow (typically August)
ME	7Q10 but considering 14Q10 or August Median

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B.7 Alternative Flow Selection Status

- NHDES has not made a final decision regarding an Alternate Flow, however we are leaning towards the August Median for reasons that include:
  - Appears to address frequency and duration concerns associated with using 7Q10
    - Flows ≤ August Median occur ~ 16% of time (see B.1 – 62 gages, ~ 30 years)
      - Over 30 times more frequent than the 7Q10 flow and about half as frequent as Summer Median Flow
    - Duration of events with flows ≤ August Median are sufficiently long for nutrient response
      - Median of 9.2 consecutive days based on 10 gages (see B.2)
    - August Median is about 4 times higher than 7Q10 (based on median of 42 USGS gages)
      - Ratios are quite variable (see B.4)
  - Median Ambient TP concentrations downstream of WWTFs start to significantly increase around August Median Flow (see B.5)
  - Is still representative of relatively dry conditions when WWTFs are likely to have greatest impact on water quality (see B.5)
  - Other NE States (MA, ME, VT) are using flows ≤ August Median (see B.6)

Comments?

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C. AMBIENT TP TARGET(S)

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C.1 Why TP Target(s) are needed?

- Response of a waterbody to nutrients is dependent on TP loading (flow x concentration), as well as other factors (see A.4)
- Needed for use in the default methodology for setting nutrient permit limits (e.g., mass-balance equation – see A.5) **when EPA/NHDES approved Site Specific Criteria (Env-Wq 1704), or other studies such as TMDLs, have <u>not</u> been conducted.**
  - Ambient TP Load in mass balance equation
    (= Ambient TP Target Concentration x Alternative Flow)
    must, with reasonable assurance, prevent nutrient related water quality standard violations.
  - Per EPA - if flow other than 7Q10 is used, the TP target concentration will likely be less than 100 ug/L (the Gold Book target they currently use).
- **TP targets for nutrient permitting are <u>not</u> TP criteria.**

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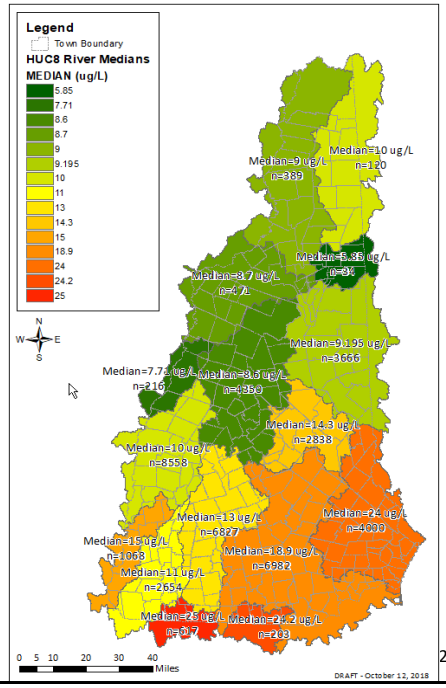
C.2.1 Existing Ambient TP Concentrations

- Important to know existing conditions before setting targets
- NH HUC 8 River Median TP Concentrations vary from **5.85 ug/L** in the north to **25 ug/L** in the south
  - Higher values are in more populated areas of the state (not natural).



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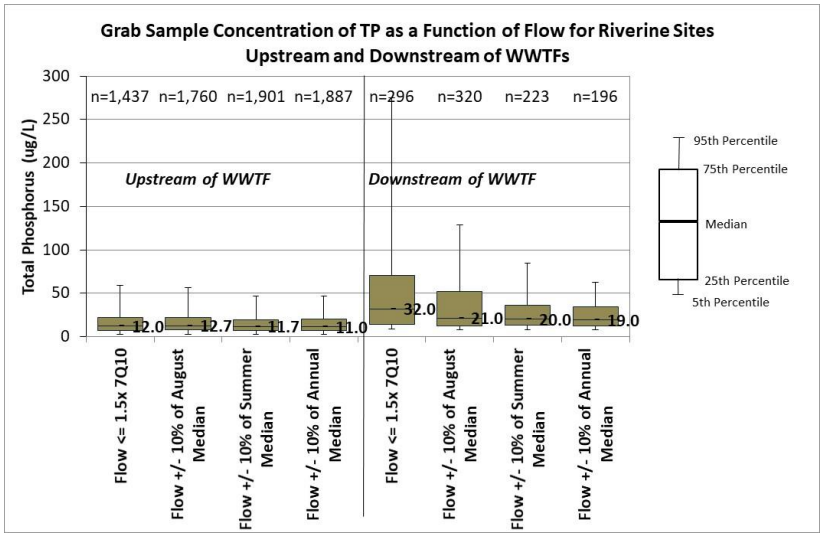
C.2.2 Existing Ambient TP Concentrations (cont.)



Median Ambient TP without upstream WWTFS is about **11-13 ug/L** regardless of flow **(relatively low)**

Median Ambient TP downstream of WWTFs almost doubles when flows are ≥ August Median (**19-21 ug/L**) and almost triples (**32 ug/L**) when flows are near 7Q10

Shows WWTF impact on ambient TP increases as flow decreases (drier weather)

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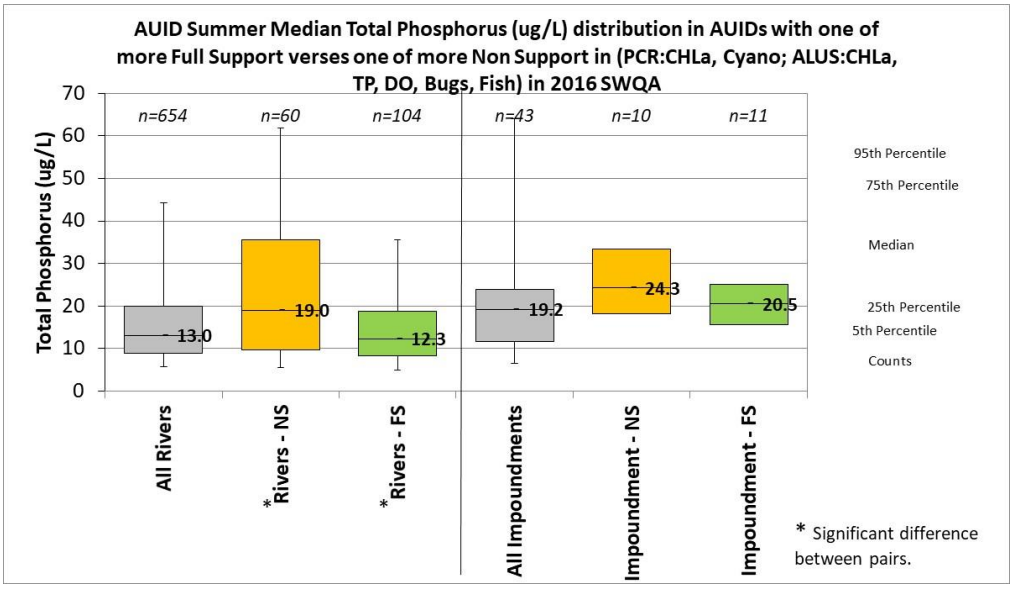
C.2.3 Existing Ambient TP Concentrations (cont.)



Significant difference between rivers with nutrient related impairments (**median of 19.0 ug/L)** and those without (**median of 12.3 ug/L**).

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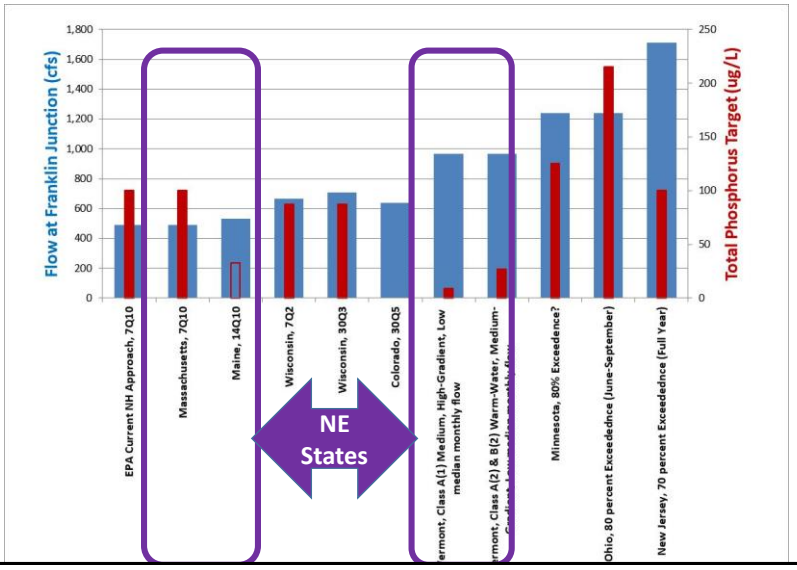
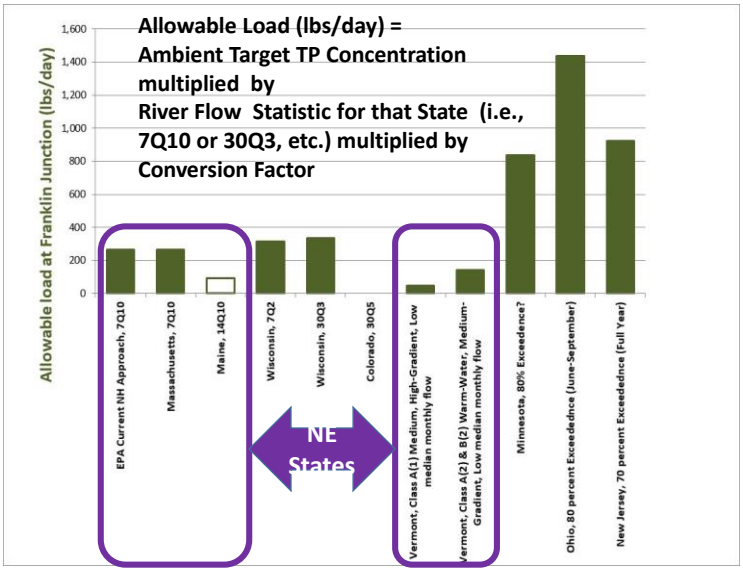
C.3.1 TP Targets - Other States



NE State	Current TP Targets (Flow Used)
NH	100 ug/L Gold Book (7Q10)
MA	100 ug/L Gold Book (7Q10)
VT	9-27 ug/L; in regulation; based on Class and macroinvertebrates (Low median monthly flow – typically August)
ME	18 – 33 ug/L; draft criteria; based on Class and various end points (7Q10 but considering 14Q10 or August Median)

C.3.2 TP Targets - Other States – Load Comparison



Allowable Downstream Loads

MA is same as NH (when 7Q10 and 100 ug/L was used)

VT and ME are lower than NH (assumes ME at 30 ug/L and 14Q10 flow)

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C.3.3TP Targets - Other States - Vermont

- 98% of Vermont Rivers Covered
- **Criteria adopted in regulation and approved by EPA**
- Summer low median monthly flow (generally August) used as index flow
- Target TP based on Endpoints;
  - Macroinvertebrate Biological Condition
- TP = **9-27 ug/L** at Summer Low Median Monthly Flow (generally August)

	Class A(1)			Class B(1)			Classes A(2) and B(2)		
Stream Type[2]	Small, High-Gradient	Medium, High-Gradient	Warm-Water, Medium Gradient	Small, High-Gradient	Medium, High-Gradient	Warm-Water, Medium Gradient	Small, High-Gradient	Medium, High-Gradient	Warm-Water, Medium Gradien
Nutrient Concentrations									
Total Phosphorus (µg/L)[3]	10	9	18	10	9	21	12	15	27

Vermont Water Quality Standards Environmental Protection **Rule** Chapter 29A (Effective January 15, 2017)

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C.3.4 TP Targets - Other States - Maine

- Draft Nutrient Criteria – not yet in regulation
- Target TP based on Endpoints by Class;
  - **Class AA & A = 18 ug/L**
    - Algae metrics on tolerant/intolerant species
    - Macroinvertebrate Trophic Condition
    - Reference stream TP 90th percentile
    - TP 75th-90th percentile for all AA & A waters with no impairments
  - **Class B = 30 ug/L**
    - Macroinvertebrate conditional probability of attainment
    - TP and Minimum DO
    - 75th percentile for sites attaining macroinvertebrate thresholds
    - TP 75th-90th percentile for all B waters with no impairments
  - **Class C = 33 ug/L**
    - Percent algae cover
    - 75th percentile for sites attaining macroinvertebrate thresholds
    - TP – Chlorophyll-a relationship

DRAFT TP Criteria

18 – 33 ug/L based on Class and various end points

Class B = 30 ug/L at 14Q10 flow (> 7Q10 but < August Median Flow)

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C.4.1 TP Targets Based on BCG and Diatoms

- BCG = Biological Condition Gradient
  - An approach **supported by EPA**
  - Defines levels of impairment due to human activities based on presence, absence, and relative abundance of several groups of taxa with various sensitivity to stressors as well as system connectivity and ecosystem attributes
  - Impairment levels are based on consensus of experienced biologists
  - Can be used to develop regulatory guidelines for nutrients

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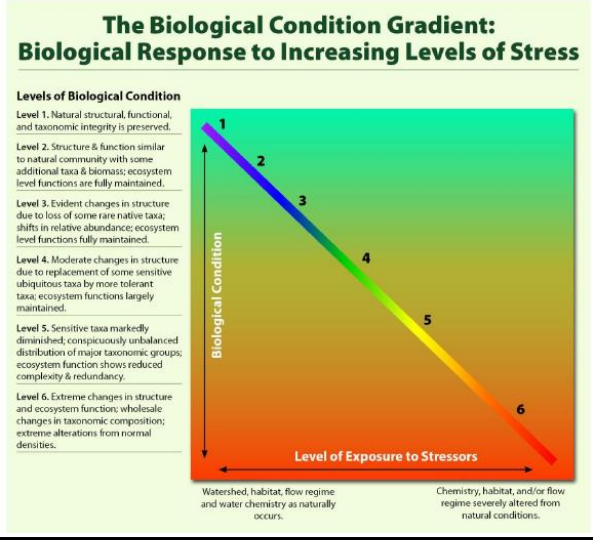
C.4.2 TP Targets Based on BCG and Diatoms (cont.)

Fact Sheet for Water Quality Managers EPA/822F-16/002 February 2016



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C.4.3 TP Targets Based on BCG and Diatoms (cont.)

- What are Diatoms?
  - Single celled algae with a cell wall of silica
- Why are they important?
  - Account for
    - ~ 20% of global carbon fixation
    - ~ 40% of marine primary productivity - a substantial basis of the marine food web
- Why Use Diatoms?
  - Many diatom species are directly sensitive to TP
  - Diatom community captures temporal variability of TP stream conditions
  - Other taxa such as fish/bugs used for aquatic life assessments are indirectly sensitive to TP

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C.4.4 TP Targets Based on BCG and Diatoms (cont.)

- **CT** – Smucker, et.al., 2013: Research conducted on CT streams indicated : " When considering ecological responses, **scientifically defensible and ecologically relevant TP criteria** were identified at…"
  (1) **20 ug/l for designating highest quality streams and restoration targets**, **sensitive taxa in good abundance.**
  (2) **40 ug/l – 65 ug/L Sensitive taxa steeply declined. Tolerant taxa increase.**
  (3) > 65 ug/l – 82 ug/L, most sensitive taxa were lost. Tolerant diatoms steeply increased to their maxima.
- **NJ** – Charles, et.al., 2019: Similarly, work based on the BCG approach and diatoms in NJ suggests that **TP criteria should range from less than or equal to 25 ug/L to no greater than 50 ug/L depending on the ecoregion.**

Acceptable range based on these CT and NJ studies is ~ 20 ug/L to 50 ug/L

Smucker, N.J., Becker, M., Detenbeck, N.E., Morrison, A.C., 2013. Using algal metrics and biomass to evaluate multiple ways of defining concentration-based nutrient criteria in streams and their ecological relevance. Ecol. Indic.32, 51-61.
Charles, D.F., Tuccillo, A.P., Belton, T.J., 2019. Use of diatoms for developing nutrient criteria for rivers and streams: A Biological Condition Gradient approach. Ecological Indicators, 96, 258-269.

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C.4.5 TP Targets Based on BCG and Diatoms (cont.)

- **Significant change in diatoms from TP sensitive to TP tolerant species could violate NH Biological and Community Integrity water quality criteria**

- Env-Wq 1703.19 Biological and Aquatic Community Integrity.

(a) All surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(b) Differences from naturally-occurring conditions shall be limited to non-detrimental differences in community structure and function.

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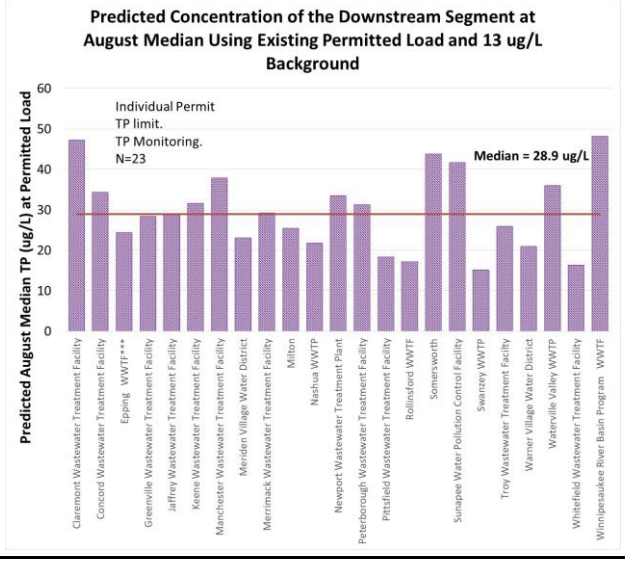
C.5 Predicted TP Target based on Mass Balance, WWTF Permitted Load, August Median Flow and 13 ug/L Background



- Predicted ambient TP target results:
  - All < 50 ug/L
  - Median ~ 30 ug/L
- Results would change if actual background is different than 13 ug/L

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C.6 TP Target Selection Status

- NHDES has not made a final decision regarding Target TPs
- Ambient Data and literature indicates range of ~ 9 ug/L to ~ 50 ug/L depending on factors such as existing condition and response parameter
- May propose more than one TP Target

Comments?

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D. FRAMEWORK FOR PERMIT GUIDANCE

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D.1 FRAMEWORK – GBMC Recommendations of 1/2/19

- Great Bay Municipal Coalition (GBMC) GBMC recommends developing framework that
  - includes critical streamflow
  - range of TP targets
  - how permitting can account for water-body specific characteristics and conditions
- Framework can then be used to develop Permitting Guidance

- GBMC recommended Framework elements are on following slides for discussion

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D.2.1 GBMC Framework Elements

1. Identification of nutrient-related response variables (e.g., dissolved oxygen, chlorophyll-a, benthic macroinvertebrates) that should be the primary indicator of whether nutrient impairments do or not occur.

Comments?

2. Identification of a range of TP targets to be utilized.

Comments?

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D.2.2 GBMC Framework Elements (cont.)

3. A description of how response variables and TP targets will be used together to determine if nutrient impairments occur.

   a. If both TP and response variables exceed targets, the system should be considered potentially impaired by nutrients.
   b. If response variables meet targets but TP does not, the system should be considered unimpaired.
   c. If response variables exceed targets but TP does not, the system should be considered impaired by factors other than nutrients.

Comments?

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D.2.3 GBMC Framework Elements (cont.)

4. A mechanism for setting water body specific TP targets to the prevailing TP concentration (within certain ranges) for water bodies with favorable response variables.
Comments?

5. A discussion of data requirements for the demonstration of the appropriate need of water body specific TP targets.
Comments?

6. Acknowledgement that water body specific TP targets can also be developed using predictive relationships such as water quality models, or application of existing, science-based TMDLs.
Comments?

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D.2.4 GBMC Framework Elements (cont.)

7. Discussion of specific TP permitting procedures:
   a. Critical streamflow
   b. Selection of TP target
      1) Consideration of the receiving water's current condition.
      2) Consideration of future condition (e.g., at full permitting discharge)
      3) Appropriateness of site-specific TP target
   c. Seasonal averaging
   d. Consideration of equitable nonpoint source reductions (where appropriate)
   e. WLA and limit calculation procedures

Comments?

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D.2.5 GBMC Framework Elements (cont.)

8. A discussion of how antidegradation policies should be applied for total phosphorus.

Comments?

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THE END

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