Phase 6 Planning Target Methodology

Briefing Paper for Management Board Meeting

November 17, 2016

In June 2017, the Chesapeake Bay Program partnership's Phase 6 modeling suite will be finalized and will be used to predict the watershed pollutant loadings that will result in attainment of Maryland, Virginia, Delaware and the District of Columbia Water Quality Standards (WQS). Those loadings must then be subdivided into basin-jurisdiction planning targets upon which the partners can base their Phase III Watershed Implementation Plan (P3WIP) development. To develop P3WIPs in accordance with the Midpoint Assessment schedule, Partnership agreement on the planning target methodology is needed in advance of the finalization of Phase 6 suite of modeling tools. To initiate the discussion, a review of the previously-used principles, considerations and methodology is provided as well as a brief overview of changes in the Phase 6 modeling tools that may impact the process.

In the 2010 Chesapeake Bay TMDL, the basin-jurisdiction allocations were based upon the following principles:

- Allocations must result in predicted attainment of WQS for dissolved oxygen, chlorophyll *a*, and water clarity in all segments of the Bay mainstem, tidal tributaries, and embayments
- The major river basins that contribute the most to the Bay water quality problems must do the most
- All tracked and reported reductions in nitrogen and phosphorus loads are credited toward achieving final assigned loads

To accommodate those principles, the past allocation process included various technical and policy components:

- Hydrologic averaging and critical periods to be used for model assessment of WQS attainment,
- Reference scenarios to define maximum controllable loads,
- Relative effectiveness calculations to define the dissolved oxygen benefit for load reductions in different geographical locations,
- Policy provisions for setting the difference between the lowest and highest basin-jurisdiction levels of effort, and
- Special headwater state considerations.

Hydrologic Period (Section 6.1.1 and Appendix F)[1]

The Phase 5 modeling suite included contiguous model simulation years between 1985 and 2005. Within that period, 6, 10 and 20 year averaging periods were considered. A 10-year hydrologic period was selected because it provided enough contrast in different hydrologic regimes to examine and understand water quality response to management actions over a wide range of wet and dry years, was

[1] The cited sections and appendices here and below are from the 2010 Chesapeake Bay TMDL document published by EPA on behalf of the jurisdictional partners.

shown to be representative of the long-term flow, and was within the capability of computational resources.

From the 12 different ten year periods available between 1985 and 2005, the period 1991-2000 was selected because:

- It was one of the 10-year periods that was closest to an integrated metric of long-term flow
- It was representative of 30-yr and long term flow in all basins
- It partially overlapped the 2003 tributary strategy assessment period (1985–1994)
- It was more recent than the tributary strategy allocation assessment period
- It overlapped the Bay Water Quality Transport Model calibration period (1993–2000)
- It was a complete decade that was straightforward for communication

Critical Conditions (Section 6.2.1 and Appendix G)

Although there is not specific guidance or regulations on how to determine critical conditions, they must be considered in TMDLs [40 CFR 130.7(c)(1)].

It was first determined that the critical period should be within the hydrologic averaging and that a 3-year period should be used to be consistent with the Chesapeake Bay water quality criteria assessment period.

Because the highest nitrogen and phosphorus loadings (and water quality impacts) occur during high flow periods, the 3-year periods between 1991 and 2000 with the highest flows were considered. Multiple statistical analyses were performed to evaluate the return frequencies associated with the periods 1996-1998 (highest flow) and 1993-1995 (second highest flow). Ultimately the 1993-1995 period was selected because its ten-year return frequency provided the best balance between guarding against extreme events and ensuring attainment during more frequent critical events.

Relative Effectiveness (Section 6.3.1)

This term describes the variable dissolved oxygen benefit associated with nutrient reductions in different geographical locations throughout the Chesapeake Bay watershed. Both riverine and estuarine transport and attenuation of nutrient loads were considered. Riverine effectiveness was determined by using the Bay Watershed Model to estimate the attenuation and loss of loads between their original input point and their delivery to tidal waters. Estuarine effectiveness was determined by performing a series of Bay Water Quality Model scenarios that individually varied fall line loads for each major river basin while holding others constant and then predicted the change in DO concentration during the summer criteria assessment period in the critical segments. Riverine and estuarine effects were combined and basin-jurisdiction effectiveness was ranked. The effectiveness scale ran from approximately 0 to 10 ug/l DO per million pounds of N reduction or 100,000 pounds of P reduction.

Reference scenarios (Section 6.3.2 and Appendix J)

(Please also review: Phase III WIP Planning Targets – Selecting the Scenario Year)

2010 No Action (NA) and 2010 E3 scenarios were developed for all sources. The No Action scenario is indicative of a theoretical worst case loading situation in which no controls exist for any sources of nutrient and sediment pollutant loads. The E3 scenario—everything by everyone, everywhere—represents a best-case possible situation where controls are represented at the fullest possible extent practicable across all sources. Each scenario can be run with any given year's land-use representation. The year 2010 was selected as the base year for both of these scenarios because it represented conditions at the time the Bay TMDL was developed. The provisions associated with each scenario are documented in Table 6-4 (see page 6-23) and Appendix J in the 2010 Chesapeake Bay TMDL document. The resultant scenario loadings were the basis for defining the maximum controllable load reductions and then coupled with the relative effectiveness assessment, attainment goals and policy decisions to calculate basin-jurisdiction allocations.

Combining Relative Effectiveness with attainment goals (Section 6.3.3 and Appendix K)

To execute the allocation, the total nitrogen and phosphorus loadings needed to achieve WQS (190 N 12.7 P (MPY)) were divided into categories of "wastewater" and "everything else". A graph plotting basin-jurisdiction effectiveness against level of effort (i.e. percent reduction between E3 and NA) was constructed with individual lines for each category. The wastewater lines (i.e. the hockey sticks) were developed first under the following conditions:

- For nitrogen, the maximum and minimum percent of controllable load prescribed for basin-jurisdictions were 90% (4.5mg/L) and 67% (8 mg/L), respectively
- For phosphorus, the maximum and minimum percent of controllable load prescribed for basin-jurisdictions were 96% (0.22 mg/L) and 85% (0.54 mg/L), respectively
- For both parameters, any relative effectiveness that was at least half of the maximum relative effectiveness value was assigned the maximum percent of controllable load (the flat part of the hockey stick)
- For both parameters, the minimum controllable load value was assigned to a relative effectiveness of zero, and all values of relative effectiveness between zero and half of the maximum value were assigned interpolated percentages (the sloped part of the stick)

After developing wastewater expectations, an "everything else" line was established with a slope that resulted in a 20 percent overall difference from highest to lowest basin-jurisdiction effectiveness. That line that was then adjusted on the graph to the location where the sum of wastewater and everything else equaled the basinwide load needed for achieving WQS.

The allocation procedures were deemed acceptable to EPA and agreed to by five of the seven jurisdictions. It is important to note that two headwater states did not agree that the process was equitable for their jurisdictions and that EPA accepted those arguments and compensated by providing increased allocations to these two headwater states. These were the "special headwater state considerations" referenced on page 1 under the allocation principles.

What's changing as part of the Bay TMDL Midpoint Assessment?

Watershed Model

- New Model Structure
- 10 additional years of monitoring data
- Different land use categories and loading rates
- New methods and/or data for fertilizer applications, manure nutrients, atmospheric deposition
- New phosphorous representation
- New Lower Susquehanna River impoundments representation
- Higher coastal plain loads
- Changes in seasonality
- New delivery factors
- Revised E3 characterizations
- Revised BMP efficiencies and new practices and control technologies

Estuary Model

- Biogeochemical changes
- Shoreline loads
- Sea level rise/wetland loss