

Applying the Decision Framework to Attaining Water Quality Standards in the Chesapeake Bay and Its Tidal Tributaries (Final version-Approved by WQGIT July 16, 2012)

The Chesapeake Bay Program (CBP) Water Quality Goal Implementation Team (WQGIT) supports the commitments of the CBP partnership to reduce nitrogen, phosphorus and sediment pollution loads in order to achieve water-quality standards in the tidal waters of the Chesapeake Bay and its tributaries. Many WQGIT activities relate to implementing the accountability framework within the *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment* (Bay TMDL), which draws significantly on adaptive -management principles and was informed by numerous decisions of the WQGIT, its workgroups, and its CBP predecessors (Water Quality Steering Committee, Nutrient Subcommittee).

This paper places the issues and actions of the WQGIT into the context of the CBP decision framework to effectively implement the Bay TMDL and achieve the associated water-quality standards. The major steps of the CBP decision framework are: articulating program goals, describe factors influencing goal attainment, assess current management efforts (and gaps), develop management strategy, develop monitoring program, assess performance, and manage adaptively.

This paper also describes how the decision framework is being used to have a more integrated approach to assess and communicate progress between three related pieces of information:

- Implementing practices to meet the Bay TMDL allocations and the jurisdictions WIPs and 2-year milestones.
- Trends of in-stream nitrogen, phosphorus, and sediment concentrations and loads throughout the watershed.
- Attainment of states' Chesapeake Bay dissolved oxygen (DO), chlorophyll-a and water clarity/submerged aquatic vegetation (SAV) water-quality standards.

Finally, this paper addresses many of the recommendation in the National Academy of Sciences (NAS) report: *Achieving Nutrient and Sediment Goals in the Chesapeake Bay*.

CBP Decision Framework Steps and Application for Achieving Water-Quality Standards:

Articulate Program Goals

The WQGIT is using the decision framework to address the nitrogen, phosphorous, and sediment allocations in the Bay TMDL (issued in December 2010) and meet applicable water-quality standards:

Restore water quality to achieve standards for DO, clarity, SAV, and chlorophyll-a in the Bay and its tidal waters by having all practices in place by 2025 that are necessary to reduce nitrogen, phosphorus, and sediment. Practices will be in place by 2017 that would achieve 60% of the necessary pollutant reductions compared to 2009.

The CBP has undertaken monitoring, modeling and research to develop the water-quality standards and calculate the nitrogen, phosphorus, and sediment load reductions needed to achieve the standards. The

water-quality standards are supportive of other CBP goal areas including habitat (e.g., clarity for SAV), and fisheries (e.g., dissolved oxygen to support key species). The standards also provide benefit for protection of human health.

Describe factors influencing goal attainment

There are four major factors that would affect the ability of the CBP partners to achieve the goal:

- Understanding the factors affecting the ecosystem response to pollutant load reductions. The CBP has scientific knowledge to support the conclusion that implementing practices for reducing nitrogen, phosphorous, and sediment loads (the Bay TMDL) will achieve water-quality standards in the Bay. This understanding is based on the current science and the associated CBP modeling system. Better understanding of the following elements could further enhance decision-making: (1) the factors affecting the time it will take to see improvements (i.e., “lag times”) between implementation and responses in water quality (NAS recommendation); (2) factors in addition to nitrogen, phosphorous, and sediment pollutant load reduction that affect response of DO, clarity, SAV, and chlorophyll; (3) the relationships among water quality improvements and the recovery of habitat and fish populations; and (4) the effect of healthy habitats and fisheries on water quality.
- Identifying the sources and their contributions nitrogen, phosphorus, and sediment pollutant loads. This is currently represented through CBP partnership’s models, USGS SPARROW models, and supporting tidal and nontidal monitoring networks and research. As described in the Bay TMDL document (Chapter 4), the sources that are modeled by the CBP partnership are based on U.S. Census Bureau and USDA Census data, federal and state permitting data, satellite imagery, and additional data submitted by seven watershed jurisdictions. Some topics to improve understanding and reduce uncertainty include incorporating additional local data, refining information on the transport of loads through the watershed, and better predicting future impacts of population growth and climate change in the watershed.
- Describing and quantifying the effects of pollution reduction practices. The pollution reduction values associated with nitrogen, phosphorous, and sediment controls that the CBP has approved for use in the models are based on extensive literature reviews and expert panel recommendations. Through its technical source sector workgroups and expert panels, the WQGIT is continuously refining these values based on new information and to take into account innovative practices. Some topics that would increase CBP’s understanding of the effectiveness and efficiency of practices include: adopting principles to verify that reported practices are, indeed, in place and functioning as designed (NAS recommendation); further quantifying the effect of variations in watershed properties (such as different types of soils) on controls; quantifying changes in BMP performance over time; and better understanding the potential future impacts of climate change on BMP performance (NAS recommendation).
- The capacity of governments and the private sector to implement practices. The jurisdictions have described their capacity (funding, authorities, and sustainability) to implement nitrogen, phosphorous, and sediment reduction practices several times over the past 2 decades. These include the tributary strategies developed during the 1990’s and again in the mid-2000s, and more recently, in the Phase I and II Watershed Implementation Plans (WIPs) and two-year

milestones (2009-2011 and 2012-2013), which also include strategies to build capacity in order to achieve pollutant reductions.

Assess Current Management Efforts (and gaps)

The overall management efforts needed for reducing nitrogen, phosphorous, and sediment are provided in the Bay TMDL and elements of its accountability framework, including WIPs and two-year milestones. The Bay TMDL, which was released in December, 2010, identifies the necessary pollution reductions of nitrogen, phosphorous, and sediment across the six states in the watershed and District of Columbia and sets pollution limits necessary to meet applicable water-quality standards in the Bay and its tidal rivers and embayments. The Bay TMDL (Section 6) sets the Bay watershed pollution load allocations for nitrogen, phosphorous, and sediment and the needed reductions from 2009 levels (see Table 1). Section 6 of the TMDL also contains allocations for each jurisdiction and major river basin. The WIPs were initially prepared in 2010 (Phase I) and modified in 2012 (Phase II) by the six Bay states and the District of Columbia articulate the actions necessary to meet the Bay TMDL.

Table 1: Summary of Nitrogen, Phosphorus and Sediment Allocations for the Bay TMDL

Parameter	Amount (pounds per year)	Percent Reduction
Nitrogen	185.9 Million	25
Phosphorous	12.5 Million	24
Sediment	6.45 Billion	20

The Bay TMDL is supported by rigorous accountability measures to ensure cleanup commitments are established and met, including short and long-term benchmarks, a tracking and accountability system for jurisdictions activities, and federal contingency actions that may be employed if jurisdictions efforts do not meet the milestone and WIP commitments (see figure 1). Federal agencies are accountable to the President’s Executive Order Strategy and the reductions contained in the jurisdictions and other agreements between a state and a federal agency or installation. The accountability framework, which is described in section 7 of the TMDL, is designed to provide reasonable assurance that the needed reductions in point and nonpoint sources will be achieved for the TMDL. Section 10 of the Bay TMDL describes the use of adaptive management to implement the accountability framework.

Overview of Accountability Process

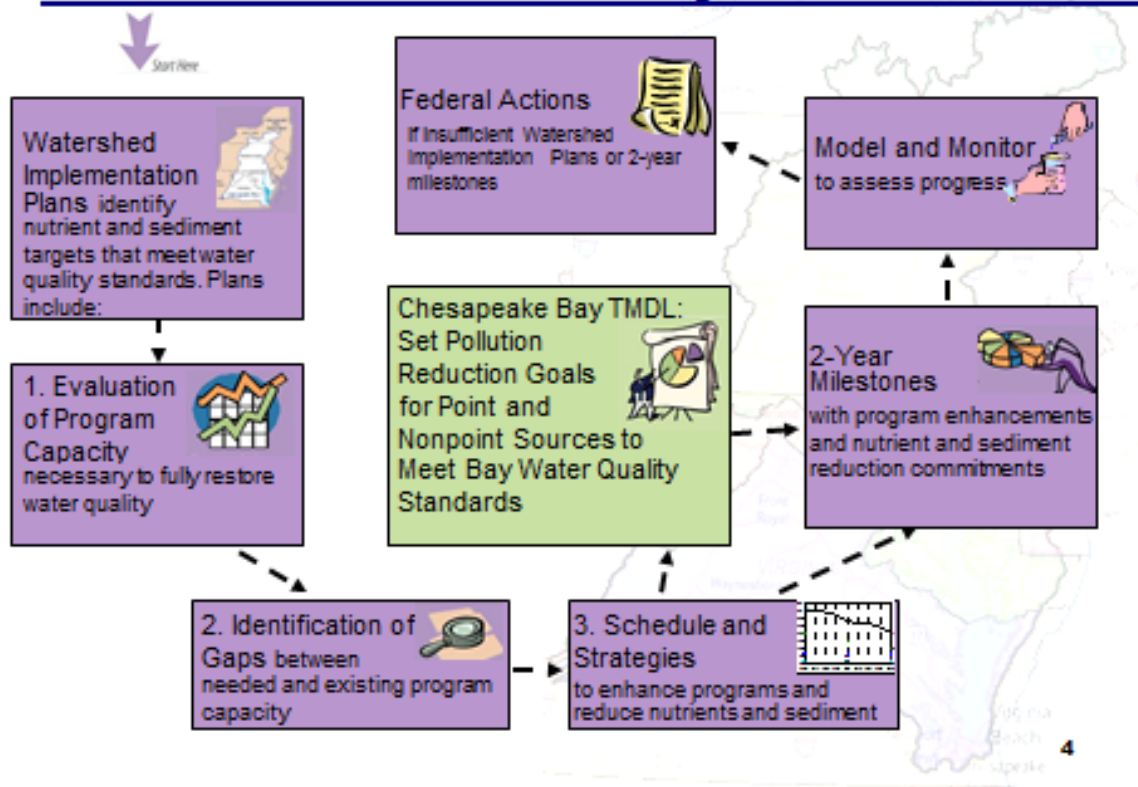


Figure 1—Overview of TMDL Accountability Framework

As part of its efforts to carry out the Bay TMDL accountability framework, the EPA interacts with the jurisdictions directly and through the WQGIT and its associated workgroups (see table 2). The WQGIT workgroups are focused on supporting the reduction of nitrogen, phosphorous, and sediment pollutant loads from key sources described in Section 4 of the Bay TMDL: wastewater, agriculture, urban storm water, septic systems, forests and air, stream and tidal shoreline erosion and associated issues of milestones and nutrient offsets and trading. The WQGIT is supported by the CBP Scientific, Technical, and Analysis (STAR) team, which contains the modeling and monitoring workgroups. The suite of CBP models and supporting monitoring data which were used to help develop the nitrogen, phosphorous, and sediment allocations are discussed in section 5 of the Bay TMDL. The CBP partnership’s models are also used to assist the jurisdictions in assessing different options for management practices in the formulation of the Phase 2 WIPs.

Table 2: Overview of Major Sources and Activities for the Bay TMDL and Associated WQGIT Workgroups

Source/Activities	Issues Addressed	WQGIT Workgroup
Agriculture	Concentrated Animal Feeding Operations (CAFOs), Manure, Biosolids, Chemical Fertilizer,	Agriculture WG
Forest	Forest management	Forestry WG
Stormwater	NPDES permitted stormwater, nonregulated stormwater runoff	Stormwater WG
Wastewater	Municipal and industrial treatment facilities, Combined Sewer Overflows, onsite systems	Wastewater WG
Atmospheric Deposition	Power Plants, automatic emissions, industry,	WQGIT, Modeling WG (which is part of STAR), sector WGs as relevant
Other Sources: Ocean, Stream Bank and Tidal Shoreline Erosion, Sediment Resuspension	Quantifying addition sources of nitrogen, phosphorous and sediment to the Bay	Modeling WG
Nutrient Trading and Offsets	Developing techniques for nutrient trading within and between jurisdictions	Trading and Offset WG
Progress toward 2-year milestones	Leading development of comparable reporting of BMP implementation toward 2-year milestones	Milestone workgroup
Improved submission of BMP data	The jurisdictions are using the National Environmental Information Exchange Network (NEIEN) system for improved submission of BMP data from the jurisdictions.	Watershed Technical Workgroup. Members of the WQGIT Watershed Technical Workgroup are responsible for helping to develop, understand, and submit data through the NEIEN system.

Some areas where the WQGIT and workgroups could benefit from enhanced information in order to implement the Bay TMDL accountability framework and attainment of water-quality standards include:

- Ecosystem Response: The CBP needs to better explain the effect of BMPs on water-quality changes in the watershed and tidal waters. The jurisdictions would benefit from improved summaries of monitoring results and factors affecting changes in nitrogen, phosphorous, and sediment loads in the watershed and progress toward water-quality standards. This information would help with evaluation of 2-year milestones and assessment of the Bay TMDL in 2017.
- Loads: Nonpoint source portion of nitrogen, phosphorous, and sediment loads could be assessed at more local scales (county and townships). The Phase 2 WIPs provide approaches for more local implementation of practices, and jurisdictions and localities could benefit from improved information on local nonpoint sources of nitrogen, phosphorous, and sediment as they develop two-

year milestones to implement these strategies. Such information could also inform the mid-point assessment and Phase III WIPs to be completed in 2017.

- **Practices:** The CBP Principals' Staff Committee has charged the WQGIT with developing a basin wide approach to tracking, verifying and reporting on nitrogen, phosphorus and sediment controls across all pollutant source sectors, including BMPs that are not supported by cost-share programs. To date, jurisdictions have not had the ability fully report non-cost shared BMPs in their annual progress reporting to CBP. Verification of historic practices may also need to be improved.
- **Capacity:** The WIPs identify potential and current gaps in funding and capacity to implement some practices and policies. Difficult and uncertain budget situations in the states and federal government may impact carrying out the WIPs and necessitate contingency actions.

Develop Management Strategy

The Bay TMDL accountability framework is a management strategy that implements the WIPs through the use of two-year milestones and a midpoint assessment in 2017.

The Phase 2 WIPs offer further details at a small geographic scale to meet the TMDL goals for 2017 and 2025. In addition to the 2-year milestones, the jurisdictions and EPA will have a more in-depth evaluation of progress in 2017 and prepare Phase 3 WIPs.

This midpoint assessment provides an opportunity for EPA to consider revising the Bay TMDL allocations and take any other necessary actions related to the WIPs or the accountability framework, including potential enhancements to the CBP models.

The workgroups in the WQGIT are using the CBP decision framework to prepare more detailed approaches for supporting the implementation of practices contained in the WIPs for each source sector (listed in Table 2). In addition to the support of management practice implementation, the WQGIT and its workgroups are assessing funding, population growth, regulatory issues, best available technology, nutrient trading, and BMP operation. The workgroups are also looking to improve data tracking and analysis of practices applicable to various source sectors.

These management strategies are being supported by STAR through the following activities:

- Assessing the potential to use multiple models and a potential modeling laboratory (NAS recommendation) to provide information on more local distribution of nitrogen, phosphorous, and sediment loads in advance of the 2017 mid-point assessment of the Bay TMDL. The EPA and USDA are also using results from the USGS SPARROW model to identify "priority agricultural watersheds", which are areas of high nutrient loading to the Bay, to focus water-quality practices.
- Improving verification of implementation of practices.
- Expanding monitoring of nitrogen, phosphorous and sediment in-stream concentrations to compute loads in the watershed (see next section on monitoring)
- Reporting on "lessons learned" from BMPs and water-quality response to help improve decision making about implementation of practices.

- Providing improved information to focus management strategies to achieve water-quality response in different portions of the estuary that will provide greatest benefit to living resources.

Develop Monitoring Program

The CBP has extensive tidal and nontidal monitoring networks, which are described in section 5 of the Bay TMDL. The networks are used to (1) measure nitrogen, phosphorous, and sediment in the watershed, (2) assess conditions in tidal waters relative to established water-quality standards, and (3) evaluate tidal habitats conditions and living resource populations and health. The CBP also has a basin wide reporting process for tracking implementation of management practices. Many of these monitoring and assessment activities are coordinated through and provided by the CBP STAR team and partner science entities. The CBP, through the STAC, conducted a review of its monitoring programs in 2009, to better align efforts with the anticipated needs of the Bay TMDL and plans future evaluation to determine if changes need to be made to address the needs of the goal teams. Findings from all of the monitoring programs will need to be used to assess of potential improvements for CBP model simulations to help develop the Phase 3 WIPs by 2017.

STAR is working with the WQGIT to develop an approach to integrate three key pieces of related water-quality information to better assess and communicate progress toward the Bay TMDL and associated water-quality standards including:

- Implementation of BMPs: Indicators for the reduction of nitrogen, phosphorous, and sediment by source, jurisdiction, and overall load reductions. These indicators are based on BMP data submitted by the jurisdictions that are run through the CBP models to estimate progress toward load reductions.
- Changes of in-stream nitrogen, phosphorous and sediment concentrations and loads: indicators of flow-adjusted trends of nitrogen, phosphorous, and sediment. These indicators show long-term (25 year) and shorter term (10 year) changes in when annual effect of streamflow variability are removed. The indicators are based on monitoring data collected as part of the CBP nontidal network.
- Indicators of attainment of Chesapeake water-quality standards for dissolved oxygen, chlorophyll-a, water clarity/SAV standards. These indicators are based primarily on results from the CBP tidal water-quality monitoring network.

There is additional monitoring and assessment to address the factors affecting annual loads, responses in living resources, and efforts underway to improve monitoring programs. The WQGIT and STAR efforts to enhance monitoring and analysis for each factio include:

- System understanding: The CBP has annual monitoring of river flow to the Bay to help explain yearly changes in DO, clarity/SAV, and chlorophyll-a conditions Additional living resources monitoring is used to assess changes in populations of lower trophic levels (SAV and invertebrates) and fisheries (crabs, oysters, and selected finfish species) that are dependent on habitat conditions. Some improvements for monitoring and system understanding include:

- Enhance analysis of tidal monitoring data to assess progress toward water-quality standards.
- Expand small watershed monitoring and assessment to better evaluate BMP efficiency,
- Produce reports explaining water-quality change and lessons learned from BMPs and water-quality response. The STAR is preparing a report on lessons learned about water quality improvements (to be done in 2012) and USGS plans reports on water-quality changes on the Delmarva (2013) and Potomac (2015).
- **Loads:** The CBP partners and USGS operate the River-Input Stations to monitor and help assess annual loads of nitrogen, phosphorous, and sediment to the Bay which are used to explain changes in estuary water quality conditions. New techniques are being developed to better compare the N, P, and S load data to TMDL allocations.
- **Practices.** Starting in 2010, CBP is using the National Environmental Information Exchange Network (NEIEN) system for improved submission of BMP data from the jurisdictions. Members of the WQGIT Watershed Technical Workgroup are responsible for helping to develop, understand, and submit data through the NEIEN system. EPA also has a new reporting system—the Bay Tracking and Accounting System, or BayTAS - to help track progress toward meeting Bay TMDL allocations. WQGIT members have been actively involved in the development of BayTAS and regularly review BayTAS reports. The CBP is working with the jurisdictions and federal partners to improve verification of reported nutrient and sediment controls. The WQGIT also adopted a protocol for reviewing the effectiveness of nutrient and sediment controls based on expert panels and the best available literature and data. At this time, 11 expert panels are underway to modify existing, or approve new, nutrient sediment controls for use by the CBP models.
- **Capacity-**The monitoring needed to track the capacity to implement practices is discussed in the previous bullet.

Assess Performance

The CBP accountability framework provides the foundation to assess performance toward the TMDL and associated water-quality standards. The established times in the accountability framework to assess performance include:

- **Assessment of Phase 2 WIPs (2011-2012).** EPA is working with the jurisdiction to assess if the Phase 2 WIPs meet EPA's expectations. This will be completed in 2012.
- **During the 2-year Milestones.** In even years of the milestones, results of previous milestone are assessed and the next round of milestone commitments is proposed and evaluated. In the odd years, an interim report of progress toward meeting the current milestone is made. All of the results are reported to the Chesapeake Executive Council (EC). This provides an assessment of performance to implement management practices and additional analysis is being planned to better communicate changes of in-stream nitrogen, phosphorous, and sediment trends and process toward Chesapeake water-quality standards.
- **2017 Midpoint Assessment.** The assessment will include any updates to the CBP models as recommended and approved by the WQGIT, as well as the development of Phase 3 WIPs. EPA will consider whether to revise the TMDL allocations based on the midpoint assessment. The assessment could also include (1) monitoring results for changes of in-stream nitrogen,

phosphorous, and sediment concentrations and loads in the watershed, (2) progress toward attainment of Chesapeake Bay water-quality standards, and (3) explanations of the relation between implementation of pollution reduction controls and changes in water quality.

Manage Adaptively

The CBP has employed adaptive management throughout the TMDL process. During 2009-2010, the jurisdictions prepared and revised Phase 1 WIPs based on EPA's evaluation. The allocations that EPA established in the Bay TMDL were based in part on the Phase I WIPs. The TMDL accountability and adaptive management frameworks, discussed in sections 7 and 10 of the Bay TMDL, respectively, describe approaches to manage adaptively from 2011 to 2025. Some specific steps where changes could occur are:

- Based on the Phase 2 WIPs.
- During formulation and assessment of each 2-year milestone.
- At the 2017 midpoint assessment, possible updates to the CBP models, development of Phase III WIPs, and if necessary, revisions to the TMDL allocations.

The WQGIT will continue to examine the follow questions to apply the CBP decision framework:

- What progress had been made in implementing practices for the Bay TMDL?
- What are the changes in water quality and progress toward water-quality standards?
- What are we learning about the factors affecting water-quality changes to better implement practices?
- What improvements are needed in modeling, monitoring, and science?
- How do we best consider the combined impacts on land change and climate variability (storm events and long-term change) on nutrient and sediment loading and implications for the TMDL?