# Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment

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Office of Water
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*and in collaboration with*

Delaware, the District of Columbia, Maryland, New York,
Pennsylvania, Virginia, and West Virginia

# CHESAPEAKE BAY TMDL EXECUTIVE SUMMARY

## INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has established the Chesapeake Bay Total Maximum Daily Load (TMDL), a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks and rivers.

Despite extensive restoration efforts during the past 25 years, the TMDL was prompted by insufficient progress and continued poor water quality in the Chesapeake Bay and its tidal tributaries. The TMDL is required under the federal Clean Water Act and responds to consent decrees in Virginia and the District of Columbia from the late 1990s. It is also a keystone commitment of a federal strategy to meet President Barack Obama's Executive Order to restore and protect the Bay.

The TMDL – the largest ever developed by EPA – identifies the necessary pollution reductions of nitrogen, phosphorus and sediment across Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia and sets pollution limits necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayments. Specifically, the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year – a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. These pollution limits are further divided by jurisdiction and major river basin based on state-of-the-art modeling tools, extensive monitoring data, peer-reviewed science and close interaction with jurisdiction partners.

The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017. The TMDL is supported by rigorous accountability measures to ensure cleanup commitments are met, including short-and long-term benchmarks, a tracking and accountability system for jurisdiction activities, and federal contingency actions that can be employed if necessary to spur progress.

Watershed Implementation Plans (WIPs), which detail how and when the six Bay states and the District of Columbia will meet pollution allocations, played a central role in shaping the TMDL. Most of the draft WIPs submitted by the jurisdictions in September 2010 did not sufficiently identify programs needed to reduce pollution or provide assurance the programs could be implemented. As a result, the draft TMDL issued September 24, 2010 contained moderate- to high-level backstop measures to tighten controls on federally permitted point sources of pollution.

A 45-day public comment period on the draft TMDL was held from September 24 to November 8, 2010. During that time, EPA held 18 public meetings in all seven Bay watershed jurisdictions, which were attended by about 2,500 citizens. EPA received more than 14,000 public comments and, where appropriate, incorporated responses to those comments in developing the final TMDL.

After states submitted the draft WIPs, EPA worked closely with each jurisdiction to revise and strengthen its plan. Because of this cooperative work and state leadership, the final WIPs were significantly improved. Examples of specific improvements include:

- Regulated point sources and non-regulated nonpoint sources of nitrogen, phosphorus, and sediment are fully considered and evaluated separately in terms of their relative contributions to water quality impairment of the Chesapeake Bay's tidal waters.
- Committing to more stringent nitrogen and phosphorus limits at wastewater treatment plants, including on the James River in Virginia. (Virginia, New York, Delaware)
- Pursuing state legislation to fund wastewater treatment plant upgrades, urban stormwater management and agricultural programs. (Maryland, Virginia, West Virginia)
- Implementing a progressive stormwater permit to reduce pollution. (District of Columbia)
- Dramatically increasing enforcement and compliance of state requirements for agriculture. (Pennsylvania)
- Committing state funding to develop and implement state-of-the-art-technologies for converting animal manure to energy for farms. (Pennsylvania)
- Considering implementation of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. (Delaware, Maryland, Virginia)

These improvements enabled EPA to reduce and remove most federal backstops, leaving a few targeted backstops and a plan for enhanced oversight and contingency actions to ensure progress. As a result, the final TMDL is shaped in large part by the jurisdictions' plans to reduce pollution, which was a long-standing priority for EPA and why the agency always provided the jurisdictions with flexibility to determine how to reduce pollution in the most efficient, cost-effective and acceptable manner.

Now the focus shifts to the jurisdictions' implementation of the WIP policies and programs that will reduce pollution on-the-ground and in-the-water. EPA will conduct oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA is committed to take appropriate contingency actions including targeted compliance and enforcement activities, expansion of requirements to obtain NPDES permit coverage for currently unregulated sources, revision of the TMDL allocations and additional controls on federally permitted sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems.

In 2011, while the jurisdictions continue to implement their WIPs, they will begin development of Phase II WIPs, designed to engage local governments, watershed organizations, conservation districts, citizens and other key stakeholders in reducing water pollution.

## TMDL BACKGROUND

The Clean Water Act (CWA) sets an overarching environmental goal that all waters of the United States be "fishable" and "swimmable." More specifically it requires states and the District of Columbia to establish appropriate uses for their waters and adopt water quality standards that are protective of those uses. The CWA also requires that every two years jurisdictions develop – with EPA approval – a list of waterways that are impaired by pollutants and do not meet water

quality standards. For those waterways identified on the impaired list, a TMDL must be developed. A TMDL is essentially a "pollution diet" that identifies the maximum amount of a pollutant the waterway can receive and still meet water quality standards.

Most of the Chesapeake Bay and its tidal waters are listed as impaired because of excess nitrogen, phosphorus and sediment. These pollutants cause algae blooms that consume oxygen and create "dead zones" where fish and shellfish cannot survive, block sunlight that is needed for underwater Bay grasses, and smother aquatic life on the bottom. The high levels of nitrogen, phosphorus and sediment enter the water from agricultural operations, urban and suburban stormwater runoff, wastewater facilities, air pollution and other sources, including onsite septic systems. Despite some reductions in pollution during the past 25 years of restoration due to efforts by federal, state and local governments; non-governmental organizations; and stakeholders in the agriculture, urban/suburban stormwater, and wastewater sectors, there has been insufficient progress toward meeting the water quality goals for the Chesapeake Bay and its tidal waters.

More than 40,000 TMDLs have been completed across the United States, but the Chesapeake Bay TMDL will be the largest and most complex thus far – it is designed to achieve significant reductions in nitrogen, phosphorus and sediment pollution throughout a 64,000-square-mile watershed that includes the District of Columbia and large sections of six states. The TMDL is actually a combination of 92 smaller TMDLs for individual Chesapeake Bay tidal segments and includes pollution limits that are sufficient to meet state water quality standards for dissolved oxygen, water clarity, underwater Bay grasses and chlorophyll-*a*, an indicator of algae levels (Figure ES-1). It is important to note that the pollution controls employed to meet the TMDL will also have significant benefits for water quality in tens of thousands of streams, creeks, lakes and rivers throughout the region.

Since 2000, the seven jurisdictions in the Chesapeake Bay watershed (Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), EPA and the Chesapeake Bay Commission, which are partners in the Chesapeake Bay Program, have been planning for a Chesapeake Bay TMDL.

Since September 2005, the seven jurisdictions have been actively involved in decision-making to develop the TMDL. During the October 2007 meeting of the Chesapeake Bay Program's Principals' Staff Committee, the Bay watershed jurisdictions and EPA agreed that EPA would establish the multi-state TMDL. Since 2008, EPA has sent official letters to the jurisdictions detailing all facets of the TMDL, including: nitrogen, phosphorus and sediment allocations; schedules for developing the TMDL and pollution reduction plans; EPA's expectations and evaluation criteria for jurisdiction plans to meet the TMDL pollution limits; reasonable assurance for controlling nonpoint source pollution; and backstop actions that EPA could take to ensure progress.

The TMDL also resolves commitments made in a number of consent decrees, Memos of Understanding, the Chesapeake Bay Foundation settlement agreement of 2010, and settlement agreements dating back to the late 1990s that address certain tidal waters identified as impaired in the District of Columbia, Delaware, Maryland and Virginia.

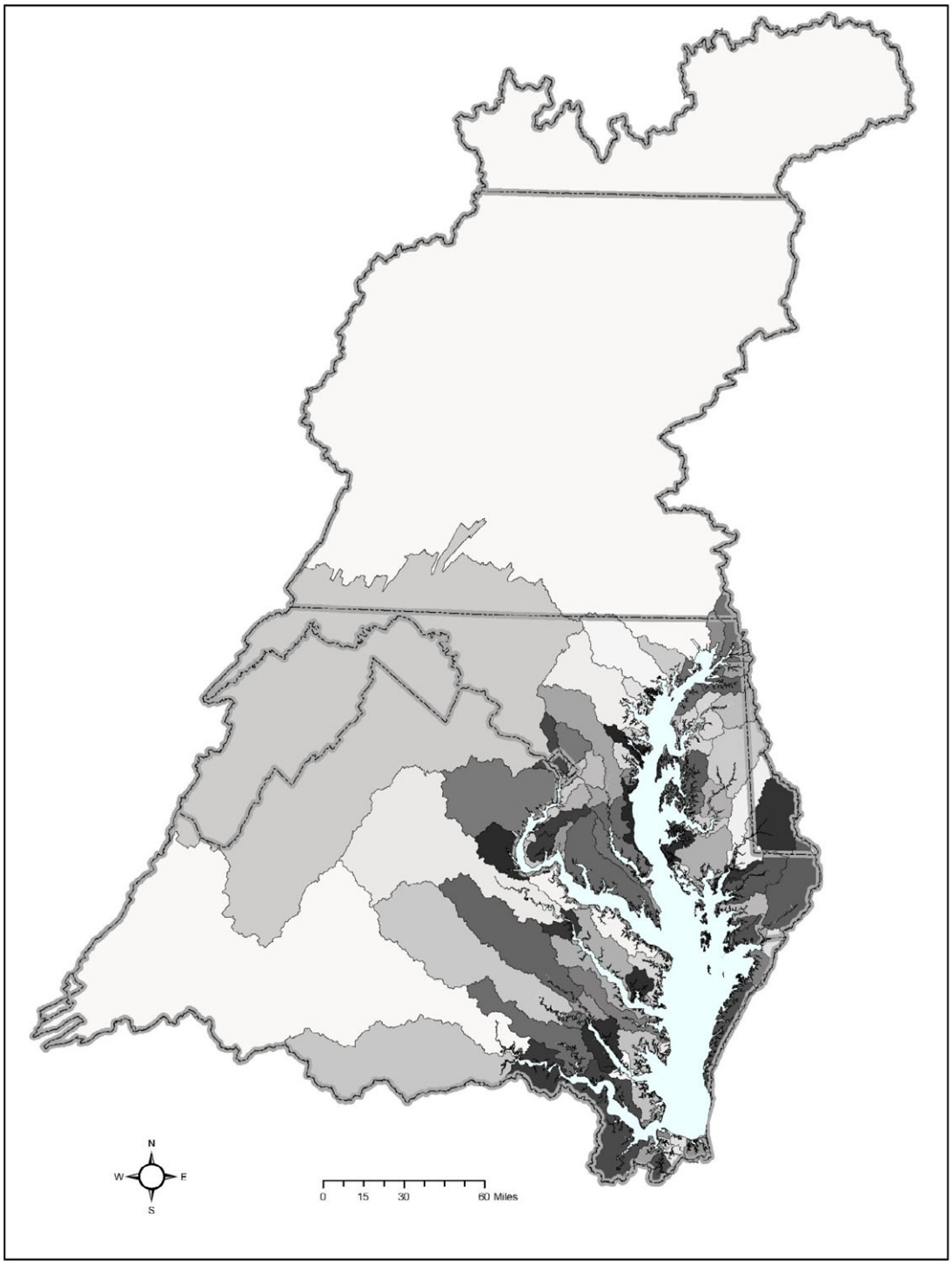


**Figure ES-1. A nitrogen, phosphorus and sediment TMDL has been developed for each of the 92 Chesapeake Bay segment watersheds.**

Additionally, President Obama issued Executive Order 13508 on May 12, 2009, which directed the federal government to lead a renewed effort to restore and protect the Chesapeake Bay and its watershed. The Chesapeake Bay TMDL is a keystone commitment in the strategy developed by 11 federal agencies to meet the President's Executive Order.

## DEVELOPING THE CHESAPEAKE BAY TMDL

Development of the Chesapeake Bay TMDL required extensive knowledge of the stream flow characteristics of the watershed, sources of pollution, distribution and acreage of the various land uses, appropriate best management practices, the transport and fate of pollutants, precipitation data and many other factors. The TMDL is informed by a series of models, calibrated to decades of water quality and other data, and refined based on input from dozens of Chesapeake Bay scientists. Modeling is an approach that uses observed and simulated data to replicate what is occurring in the environment to make future predictions, and was a critical and valuable tool to develop the Chesapeake Bay TMDL.

The development of the TMDL consisted of several steps:

1. EPA provided the jurisdictions with loading allocations for nitrogen, phosphorus and sediment for the major river basins by jurisdiction.
2. Jurisdictions developed draft Phase I WIPs to achieve those basin-jurisdiction allocations. In those draft WIPs, jurisdictions made decisions on how to further sub-allocate the basin-jurisdiction loadings to various individual point sources and a number of point and nonpoint source pollution sectors.
3. EPA evaluated the draft WIPs and, where deficiencies existed, EPA provided backstop allocations in the draft TMDL that consisted of a hybrid of the jurisdiction WIP allocations modified by EPA allocations for some source sectors to fill gaps in the WIPs.
4. The draft TMDL was published for a 45-day public comment period and EPA held 18 public meetings in all six states and the District of Columbia. Public comments were received, reviewed and considered for the final TMDL.
5. Jurisdictions, working closely with EPA, revised and strengthened Phase I WIPs and submitted final versions to EPA.
6. EPA evaluated the final WIPs and used them along with public comments to develop the final TMDL.

Since nitrogen and phosphorus loadings from all parts of the Bay watershed have an impact on the impaired tidal segments of the Bay and its rivers, it was necessary for EPA to allocate the nitrogen and phosphorus loadings in an equitable manner to the states and basins. EPA used three basic guides to divide these loads.

- Allocated loads should protect living resources of the Bay and its tidal tributaries and should result in all segments of the Bay mainstem, tidal tributaries and embayments meeting water quality standards for dissolved oxygen, chlorophyll *a*, water clarity and underwater Bay grasses.
- Tributary basins that contribute the most to the Bay water quality problems must do the most to resolve those problems (on a pound-per-pound basis) (Figure ES-2).
- All tracked and reported reductions in nitrogen, phosphorus and sediment loads are credited toward achieving final assigned loads.

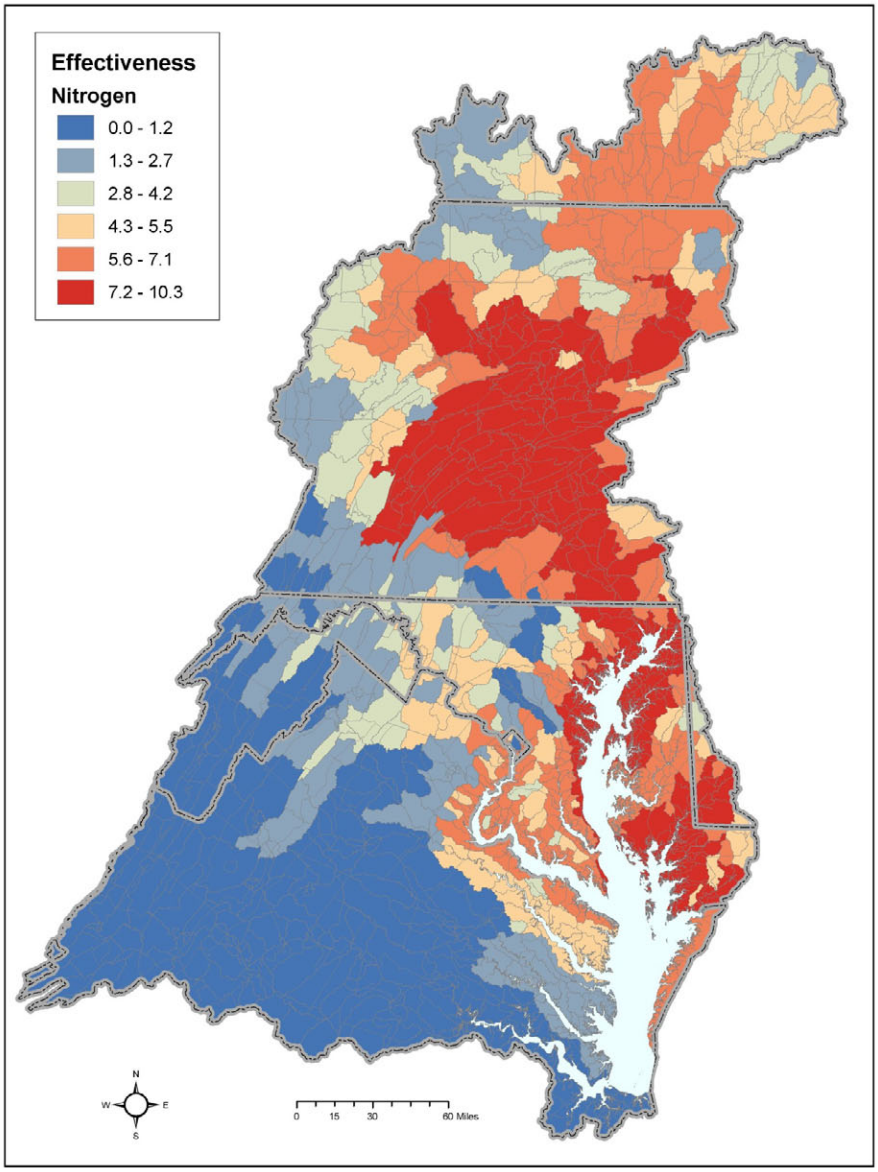


**Figure ES-2. Sub-basins across the Chesapeake Bay watershed with the highest (red) to lowest (blue) pound for pound nitrogen pollutant loading effect on Chesapeake Bay water quality.**

In addition, EPA has committed to reducing air deposition of nitrogen to the tidal waters of the Chesapeake Bay from 17.9 to 15.7 million pounds per year. The reductions will be achieved through implementation of federal air regulations during the coming years.

To ensure that these pollutant loadings will attain and maintain applicable water quality standards, the TMDL calculations were developed to account for critical environmental conditions a waterway would face and seasonal variation. An implicit margin of safety for nitrogen and phosphorus, and an explicit margin of safety for sediment, also are included in the TMDL.

Ultimately, the TMDL is designed to ensure that by 2025 all practices necessary to fully restore the Bay and its tidal waters are in place, with at least 60 percent of the actions taken by 2017.

The TMDL loadings to the basin-jurisdictions are provided in Table ES-1. These loadings were determined using the best peer-reviewed science and through extensive collaboration with the jurisdictions and are informed by the jurisdictions' Phase I WIPs.

**Table ES-1. Chesapeake Bay TMDL watershed nitrogen, phosphorus and sediment final allocations by jurisdiction and by major river basin.**

| Jurisdiction | Basin | Nitrogen allocations (million lbs/year) | Phosphorus allocations (million lbs/year) | Sediment allocations (million lbs/year) |
|---|---|---|---|---|
| Pennsylvania | Susquehanna | 68.90 | 2.49 | 1,741.17 |
| | Potomac | 4.72 | 0.42 | 221.11 |
| | Eastern Shore | 0.28 | 0.01 | 21.14 |
| | Western Shore | 0.02 | 0.00 | 0.37 |
| | **PA Total** | **73.93** | **2.93** | **1,983.78** |
| Maryland | Susquehanna | 1.09 | 0.05 | 62.84 |
| | Eastern Shore | 9.71 | 1.02 | 168.85 |
| | Western Shore | 9.04 | 0.51 | 199.82 |
| | Patuxent | 2.86 | 0.24 | 106.30 |
| | Potomac | 16.38 | 0.90 | 680.29 |
| | **MD Total** | **39.09** | **2.72** | **1,218.10** |
| Virginia | Eastern Shore | 1.31 | 0.14 | 11.31 |
| | Potomac | 17.77 | 1.41 | 829.53 |
| | Rappahannock | 5.84 | 0.90 | 700.04 |
| | York | 5.41 | 0.54 | 117.80 |
| | James | 23.09 | 2.37 | 920.23 |
| | **VA Total** | **53.42** | **5.36** | **2,578.90** |
| District of Columbia | Potomac | 2.32 | 0.12 | 11.16 |
| | **DC Total** | **2.32** | **0.12** | **11.16** |
| New York | Susquehanna | 8.77 | 0.57 | 292.96 |
| | **NY Total** | **8.77** | **0.57** | **292.96** |
| Delaware | Eastern Shore | 2.95 | 0.26 | 57.82 |
| | **DE Total** | **2.95** | **0.26** | **57.82** |
| West Virginia | Potomac | 5.43 | 0.58 | 294.24 |
| | James | 0.02 | 0.01 | 16.65 |
| | **WV Total** | **5.45** | **0.59** | **310.88** |
| **Total Basin/Jurisdiction Draft Allocation** | | **185.93** | **12.54** | **6,453.61** |
| **Atmospheric Deposition Draft Allocationa** | | **15.7** | **N/A** | **N/A** |
| **Total Basinwide Draft Allocation** | | **201.63** | **12.54** | **6,453.61** |

[a] Cap on atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters to be achieved by federal air regulations through 2020.

## ACCOUNTABILITY AND GOALS

The Chesapeake Bay TMDL is unique because of the extensive measures EPA and the jurisdictions have adopted to ensure accountability for reducing pollution and meeting deadlines for progress. The TMDL will be implemented using an accountability framework that includes WIPs, two-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal contingency actions if the jurisdictions do not meet their commitments. This accountability framework is being established in part to provide demonstration of the reasonable assurance provisions of the Chesapeake Bay TMDL pursuant to both the Clean Water Act (CWA) and the Chesapeake Bay Executive Order, but is not part of the TMDL itself.

When EPA establishes or approves a TMDL that allocates pollutant loads to both point and nonpoint sources, it determines whether there is a "reasonable assurance" that the point and nonpoint source loadings will be achieved and applicable water quality standards will be attained. Reasonable assurance for the Chesapeake Bay TMDL is provided by the numerous federal, state and local regulatory and non-regulatory programs identified in the accountability framework that EPA believes will result in the necessary point and nonpoint source controls and pollutant reduction programs. The most prominent program is the CWA's National Pollutant Discharge Elimination System (NPDES) permit program that regulates point sources throughout the nation. Many nonpoint sources are not covered by a similar federal permit program; as a result, financial incentives, other voluntary programs and state-specific regulatory programs are used to achieve nonpoint source reductions. These federal tools are supplemented by a variety of state and local regulatory and voluntary programs and other commitments of the federal government set forth in the Executive Order strategy and identified in the accountability framework.

Beginning in 2012, jurisdictions (including the federal government) are expected to follow two-year milestones to track progress toward reaching the TMDL's goals. In addition, the milestones will demonstrate the effectiveness of the jurisdictions' WIPs by identifying specific near-term pollutant reduction controls and a schedule for implementation (see next section for further description of WIPs). EPA will review these two-year milestones and evaluate whether they are sufficient to achieve necessary pollution reductions and, through the use of a Bay TMDL Tracking and Accountability System, determine if milestones are met.

If a jurisdiction's plans are inadequate or its progress is insufficient, EPA is committed to take the appropriate contingency actions to ensure pollution reductions. These include expanding coverage of NPDES permits to sources that are currently unregulated, increasing oversight of state-issued NPDES permits, requiring additional pollution reductions from point sources such as wastewater treatment plants, increasing federal enforcement and compliance in the watershed, prohibiting new or expanded pollution discharges, redirecting EPA grants, and revising water quality standards to better protect local and downstream waters.

### *Watershed Implementation Plans*

The cornerstone of the accountability framework is the jurisdictions' development of WIPs, which serve as roadmaps for how and when a jurisdiction plans to meet its pollutant allocations under the TMDL. In their Phase I WIPs, the jurisdictions were expected to subdivide the Bay TMDL allocations among pollutant sources; evaluate their current legal, regulatory,

programmatic and financial tools available to implement the allocations; identify and rectify potential shortfalls in attaining the allocations; describe mechanisms to track and report implementation activities; provide alternative approaches; and outline a schedule for implementation.

EPA provided the jurisdictions with detailed expectations for WIPs in November 2009 and evaluation criteria in April 2010. To assist with WIP preparation, EPA provided considerable technical and financial assistance. EPA worked with the jurisdictions to evaluate various "what if" scenarios – combinations of practices and programs that could achieve their pollution allocations.

The two most important criteria for a WIP is that it achieves the basin-jurisdiction pollution allocations and meets EPA's expectations for providing reasonable assurance that reductions will be achieved and maintained, particularly for non-permitted sources like runoff from agricultural lands and currently unregulated stormwater from urban and suburban lands.

After the draft Phase I WIP submittals in September 2010, a team of EPA sector experts conducted an intense evaluation process, comparing the submissions with EPA expectations. The EPA evaluation concluded that the pollution controls identified in two of the seven jurisdictions' draft WIPs could meet nitrogen and phosphorus allocations and five of the seven jurisdictions' draft WIPs could meet sediment allocations. The EPA evaluation also concluded that none of the seven draft Phase I WIPs provided sufficient reasonable assurance that pollution controls identified could actually be implemented to achieve the nitrogen, phosphorus and sediment reduction targets by 2017 or 2025.

In response to its findings, EPA developed a draft TMDL that established allocations based on using the adequate portions of the jurisdictions' draft WIP allocations along with varying degrees of federal backstop allocations in all seven jurisdictions. Backstop allocations focused on areas where EPA has the federal authority to control pollution allocations through NPDES permits, including wastewater treatment plants, stormwater permits, and animal feeding operations.

## *Public Participation*

The draft Chesapeake Bay TMDL was developed through a highly transparent and engaging process during the past two years. The outreach effort included hundreds of meetings with interested groups; two rounds of public meetings, stakeholder sessions and media interviews in all six states and the District of Columbia in fall of 2009 and 2010; a dedicated EPA website; a series of monthly interactive webinars; notices published in the Federal Register; and a close working relationship with Chesapeake Bay Program committees representing citizens, local governments and the scientific community.

The release of the draft Chesapeake Bay TMDL on September 24, 2010 began a 45-day public comment period that concluded on November 8, 2010. During the comment period EPA conducted 18 public meetings in all six states and the District of Columbia. More than 2,500 people participated in the public meetings. Seven of these meetings were also broadcast live online. During the six weeks that EPA officials traveled around the watershed, they also held dozens of meetings with stakeholders, including local governments, agriculture groups, homebuilder and developer associations, wastewater industry representatives and environmental

organizations. EPA received more than 14,000 comments – most of which supported the TMDL – and the Agency's response to those comments is included as an appendix to the TMDL.

## *Final Watershed Implementation Plans and TMDL*

Since submittal of the draft WIPs and release of the draft TMDL in September 2010, EPA worked closely with each jurisdiction to revise and strengthen its plan. Because of this cooperative work and state leadership, the final WIPs were significantly improved. Examples of specific improvements include:

- Committing to more stringent nitrogen and phosphorus limits at wastewater treatment plants, including on the James River in Virginia. (Virginia, New York, Delaware)
- Pursuing state legislation to fund wastewater treatment plant upgrades, urban stormwater management and agricultural programs. (Maryland, Virginia, West Virginia)
- Implementing a progressive stormwater permit to reduce pollution. (District of Columbia)
- Dramatically increasing enforcement and compliance of state requirements for agriculture. (Pennsylvania)
- Committing state funding to develop and implement state-of-the-art-technologies for converting animal manure to energy for farms. (Pennsylvania)
- Considering implementation of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. (Delaware, Maryland, Virginia)

These improvements enabled EPA to reduce and remove most federal backstops, leaving a few targeted backstops and a plan for enhanced oversight and contingency actions to ensure progress.

### Backstop Allocations, Adjustments, and Actions

Despite the significant improvement in the final WIPs, one of the jurisdictions did not meet all of its target allocations and two of the jurisdictions did not fully meet EPA's expectations for reasonable assurance for specific pollution sectors. To address these few remaining issues, EPA included in the final TMDL several targeted backstop allocations, adjustments and actions. As a result of the jurisdictions' significant improvements combined with EPA's backstops, EPA believes the jurisdictions are in a position to implement their WIPs and achieve the needed pollution reductions. This approach endorses jurisdictions' pollution reduction commitments, gives them the flexibility to do it their way first, and signals EPA's commitment to fully use its authorities as necessary to reduce pollution.

New York Wastewater – Backstop Allocation

- EPA closed the numeric gap between New York's WIP and its modified allocations by establishing a backstop that further reduces New York's wasteload allocation for wastewater. EPA is establishing an aggregate wasteload allocation for wastewater treatment plants.
- EPA calculated this backstop WLA using the nitrogen and phosphorus performance levels that New York committed to, but assumes that significant wastewater treatment plants (WWTPs) are at current flow rather than design flow.

- EPA understands that New York plans to renew and/or modify WWTP permits upon completion of its Phase II WIP, consistent with the applicable TMDL allocations at that time. New York is reviewing engineering reports from WWTPs and, in its Phase II WIP, will provide information to support individual WLAs for these plants.

Pennsylvania Urban Stormwater – Backstop Adjustment

- EPA transferred 50 percent of the stormwater load that is not currently subject to NPDES permits from the load allocation to the wasteload allocation. The TMDL allocation adjustment increases reasonable assurance that pollution allocations from urban stormwater discharges will be achieved and maintained by signaling that EPA is prepared to designate any of these discharges as requiring NPDES permits. Urban areas would only be subject to NPDES permit conditions protective of water quality as issued by Pennsylvania upon designation. EPA will consider this step if Pennsylvania does not demonstrate progress toward reductions in urban loads identified in the WIP. EPA may also pursue designation activities based on considerations other than TMDL and WIP implementation.
- EPA will maintain close oversight of general permits for the Pennsylvania stormwater sector (PAG-13 and PAG-2) and may object if permits are not protective of water quality standards and regulations. Upon review of Pennsylvania's Phase II WIP, EPA will revisit the wasteload allocations for wastewater treatment plants, including more stringent phosphorus limits, in the event that Pennsylvania does not reissue PAG-13 and PAG-2 general permits for Phase II MS4s and construction that are protective of water quality by achieving the load reductions called for in Pennsylvania's Phase I WIP.

West Virginia Agriculture – Backstop Adjustment

- EPA shifted 75 percent of West Virginia's animal feeding operation (AFO) load into the wasteload allocation and assumed full implementation of barnyard runoff control, waste management and mortality composting practices required under a CAFO permit on these AFOs. The shift signals that any of these operations could potentially be subject to state or federal permits as necessary to protect water quality. AFOs would only be subject to NPDES permit conditions as issued by West Virginia upon designation. EPA will consider this step if West Virginia does not achieve reductions in agricultural loads as identified in the WIP. EPA may also pursue designation activities based upon considerations other than TMDL and WIP implementation.
- Based upon West Virginia's ability to demonstrate near-term progress implementing the agricultural section of its WIP, including CAFO Program authorization and permit applications and issuance, EPA will assess in the Phase II WIP whether additional federal actions, such as establishing more stringent wasteload allocations for wastewater treatment plants, are necessary to ensure that TMDL allocations are achieved.

### Enhanced Oversight and Contingencies

While final WIPs were significantly improved and the jurisdictions deserve credit for the efforts, EPA also has minor concerns with the assurance that pollution reductions can be achieved in certain pollution sectors in Pennsylvania, Virginia and West Virginia. EPA has informed these jurisdictions that it will consider future backstops if specific near-term progress is not demonstrated in the Phase II WIP.

Pennsylvania Agriculture

- Based on Pennsylvania's ability to demonstrate near-term progress implementing the agricultural section of its WIP, including EPA approval for its CAFO program and enhanced compliance assurance with state regulatory programs, EPA will assess in the Phase II WIP whether additional federal actions, such as shifting AFO loads from the load allocation to the wasteload allocation or establishing more stringent wasteload allocations for WWTPs, are necessary to ensure that TMDL allocations are achieved.

Pennsylvania Wastewater

- EPA established individual wasteload allocations for wastewater treatment plants in the TMDL to ensure that sufficient detail is provided to inform individual permits for sources within the wasteload allocation. Individual allocations do not commit wastewater plants to greater reductions than what the state has proposed in its WIP. Provisions of the TMDL allow, under certain circumstances, for modifications of allocations within a basin to support offsets and trading opportunities.
- EPA will assess Pennsylvania's near-term urban stormwater and agriculture program progress and determine whether EPA should modify TMDL allocations to assume additional reductions from wastewater treatment plants.

Virginia Urban Stormwater

- If the statewide rule and/or the Phase II WIP do not provide additional assurance regarding how stormwater discharges outside of MS4 jurisdictions will achieve nitrogen, phosphorus, and sediment reductions proposed in the final Phase I WIP and assumed within the TMDL allocations, EPA may shift a greater portion of Virginia's urban stormwater load from the load allocation to the wasteload allocation. This shift would signal that substantially more stormwater could potentially be subject to NPDES permits issued by the Commonwealth as necessary to protect water quality.

West Virginia Urban Stormwater

- If stormwater rules and/or the Phase II WIP do not provide additional assurance regarding how urban stormwater discharges outside of MS4 jurisdictions will achieve nitrogen, phosphorus, and sediment allocations proposed in the final Phase I WIP and assumed within the TMDL load allocations, EPA may shift a greater portion of West Virginia's urban stormwater load from the load allocation to the wasteload allocation. The shift would signal that substantially more urban stormwater could potentially be subject to state permit coverage and/or federal Clean Water Act permit coverage as necessary to protect water quality.

West Virginia Wastewater

- EPA established individual wasteload allocations for significant wastewater treatment plants in the TMDL to ensure that sufficient detail is provided to inform individual permits for sources within the wastewater wasteload allocation. Individual allocations do not commit wastewater plants to greater reductions than what the state has proposed in its WIP. Provisions of this TMDL allow, under certain circumstances, for modifications of allocations within a basin to support offsets and trading opportunities.

- EPA will assess West Virginia's near-term agriculture program progress and determine whether additional federal actions consistent with EPA's December 29, 2009 letter, such as modifying TMDL allocations to assume additional reductions from wastewater treatment plants, are necessary to ensure that TMDL allocations are achieved.

### Ongoing oversight of Chesapeake Bay jurisdictions

EPA will carefully review programs and permits in all jurisdictions. EPA's goal is for jurisdictions to successfully implement their WIPs, but EPA is prepared to take necessary actions in all jurisdictions for insufficient WIP implementation or pollution reductions. Federal actions can be taken at any time, although EPA will engage particularly during two-year milestones and refining the TMDL in 2012 and 2017. Actions include:

- Expanding coverage of NPDES permits to sources that are currently unregulated
- Increasing oversight of state-issued NPDES permits
- Requiring additional pollution reductions from federally regulated sources
- Increasing federal enforcement and compliance
- Prohibiting new or expanded pollution discharges
- Conditioning or redirecting EPA grants
- Revising water quality standards to better protect local and downstream waters
- Discounting nutrient and sediment reduction progress if jurisdiction cannot verify proper installation and management of controls

## FINAL TMDL

As a result of the significantly improved WIPs and the removal and reduction of federal backstops, the final TMDL is shaped in large part by the jurisdictions' plans to reduce pollution. Jurisdiction-based solutions for reducing pollution was a long-standing priority for EPA and why the agency always provided the jurisdictions with flexibility to determine how to reduce pollution in the most efficient, cost-effective and acceptable manner.

Now, the focus shifts to jurisdictions' implementation of the WIP policies and programs designed to reduce pollution on-the-ground and in-the-water. EPA will conduct oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA will utilize contingencies to place additional controls on federally permitted sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems, as well as target compliance and enforcement activities.

Federal agencies will greatly contribute to restoration of the Chesapeake Bay watershed, particularly through implementation of the new federal strategy created under President Obama's Executive Order. Eleven federal agencies have committed to a comprehensive suite of actions and pursuit of critical environmental goals on the same 2025 timeline as the TMDL. Additionally, federal agencies will be establishing and meeting two-year milestones, with the specific charge of taking actions that directly support the jurisdictions in reducing pollution and restoring water quality.

The jurisdictions are expected to submit Phase II WIPs that provide local area pollution targets for implementation on a smaller scale; the timeframe for these Phase II WIPs will be determined in early 2011. Phase III WIPs in 2017 are expected to be designed to provide additional detail of restoration actions beyond 2017 and ensure that the 2025 goals are met.

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# Foreword

This document describes the technical, legal, and policy underpinnings of the Chesapeake Bay Total Maximum Daily Load (TMDL). While EPA Regions 2 and 3 are establishing this TMDL, it represents the product of decades of scientific research, monitoring, assessment, and model application, and years of focused dialogue and analysis among EPA, our six watershed state partners and the District of Columbia, and numerous stakeholders. This document has benefited from the input of thousands of professionals and citizens dedicated to the restoration of the Chesapeake Bay. In accordance with the Clean Water Act and Executive Order 13508 (signed by President Obama on May 12, 2009), the Chesapeake Bay TMDL provides a critical plan to restore and maintain the living resources of the Chesapeake Bay.

A TMDL is required by the Clean Water Act for waters that are on state lists identifying waters that are impaired – i.e., not attaining state adopted and EPA approved water quality standards. Most of the waters of the Chesapeake Bay and its tidal tributaries and embayments are on the three states' (Maryland, Virginia, and Delaware) and the District's lists of impaired waters because of excess nitrogen, phosphorus, and sediment pollution. The Chesapeake Bay TMDL identifies the loadings of nitrogen, phosphorus, and sediment that are necessary to achieve the applicable jurisdiction's water quality standards for the Bay and its tidal tributaries and embayments for dissolved oxygen, chlorophyll *a* (an indicator of algae), water clarity, and submerged aquatic vegetation (SAV, or underwater Bay grasses). For this reason, the Chesapeake Bay TMDL has been described as a pollution diet defining the pollutant loadings necessary to attain water quality standards and restore the aquatic life resources of the Chesapeake Bay.

The Chesapeake Bay receives waters from thousands of streams and rivers within seven jurisdictions in the mid-Atlantic region of the United States: Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia. These waters drain to the Chesapeake Bay and, therefore, contribute pollutant loadings to the Bay. The Chesapeake Bay TMDL also establishes total maximum daily loads from these watersheds and jurisdictions for each of the 92 impaired segments that comprise the waters of the Chesapeake Bay and its tidal tributaries and embayments. Thus, the Chesapeake Bay TMDL is actually an assemblage of 276 TMDLs: individual TMDLs for each of the 3 pollutants— nitrogen, phosphorus, and sediment— for each of the 92 segments (3 x 92 = 276).

The purpose of the Chesapeake Bay TMDL is to identify the pollutant loading reductions needed to meet the applicable Bay water quality standards. The TMDL, thus, allocates loads to all pollutant source sectors in all parts of the Bay's 64,000 square mile watershed. Because of the watershed-wide nature of these loading reductions, the water quality benefits from these reductions will not be limited to the Bay and its tidal tributaries and embayments. In fact, the watershed's headwaters from the location the pollutant reductions are made to the point they enter the Bay or its tidal tributaries should benefit from some measure of improved water quality. The controls necessary to reduce nitrogen, phosphorus, and sediment also are likely to reduce other pollutants like bacteria and chemical contaminants.

While the Chesapeake Bay TMDL establishes the pollutant loadings for nitrogen, phosphorus, and sediment needed to restore and maintain a healthy Bay, the TMDL is essentially an

information and planning tool that does not, by itself, implement the needed controls. Implementation mechanisms available under other provisions of the Clean Water Act, Clean Air Act, state laws, and federal and state regulations, and local ordinances, as well as appropriate levels of funding, are needed to achieve these loading targets. The Bay TMDL will be implemented using an accountability framework that includes the seven jurisdictions' Watershed Implementation Plans (WIPs), two-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal actions if the Bay watershed jurisdictions do not meet their targets and commitments. Although not itself an element of the Chesapeake Bay TMDL, the accountability framework is being established pursuant to both section 117(g)(1) of the Clean Water Act and Executive Order 13508, in part, to demonstrate reasonable assurance that the Chesapeake Bay TMDL allocations for nitrogen, phosphorus, and sediment and the jurisdictions' water quality standards are met.

An executive summary provides an overview of the TMDL, highlighting its more important aspects. For more specific information, readers should consult the main document, which describes each aspect of the Chesapeake Bay TMDL in detail. Finally, for additional background and supportive material, the reader is referred to the references contained in the main document and numerous appendices.

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# Acknowledgements

This document was developed through the collaborative efforts of the U.S. Environmental Protection Agency (EPA) and its seven Chesapeake Bay watershed partners—Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia—principally through the Chesapeake Bay Program's (CBP) Water Quality Goal Implementation Team (WQGIT) (formerly the Water Quality Steering Committee), its principal workgroups, and the former Nutrient Subcommittee. The CBP's Principals' Staff Committee made decisions on behalf of the partnership and provided policy direction to the WQGIT. Advice, direction, and independent peer review were provided by the CBP's Scientific and Technical Advisory Committee (STAC), the Local Government Advisory Committee (LGAC), and the Citizen's Advisory Committee (CAC). Comments and recommendations gathered through the November–December 2009 public meetings/webinars, the monthly webinars scheduled during 2010, and the September—November 2010 public comment period were instrumental in ensuring that the published allocations provide the most benefits to local streams and rivers and still achieve the jurisdictions' Chesapeake Bay water quality standards.

The document resulted from the collaborative expertise, input, feedback, and formal comments of thousands of individuals from the multitude of CBP partnering agencies and institutions, local governments, nongovernmental organizations, businesses, many other involved stakeholders, and the general public. Their individual and collective contributions are hereby acknowledged.

Special acknowledgment is made to past and present members the following CBP committees: WQGIT, Principals' Staff Committee, Management Board, STAC, LGAC, CAC, Agriculture Workgroup, Forestry Workgroup, Sediment Workgroup, Urban and Suburban Stormwater Workgroup, Wastewater Treatment Workgroup, Watershed Technical Workgroup, TMDL Workgroup (formerly Reevaluation Technical Workgroup), the former Nutrient Subcommittee, Scientific and Technical Analysis and Reporting Team, Criteria Assessment Procedures Workgroup, Modeling Workgroup, Nontidal Water Quality Workgroup, Tidal Monitoring and Analysis Workgroup, Analytical Methods and Quality Assurance Workgroup, and former Monitoring and Analysis Subcommittee. Appendix A provides a detailed member listing of these committees, teams, and workgroups who were instrumental in completing the Chesapeake Bay total maximum daily load (TMDL).

Special acknowledgement is also made to the following individuals (in alphabetical order) for their contributions to the development of the Bay TMDL, support of the development of the jurisdictions' Phase I Watershed Implementation Plans (WIPs), evaluation of the draft and final Phase I WIPs, supporting public and stakeholder outreach, responding to thousands of public comments, and publication of this document: Greg Allen, EPA Region 3 CBP Office; Katherine Antos, EPA Region 3 CBP Office; Cheryl Atkinson, EPA Region 3 Water Protection Division (WPD); Seth Ausubel, EPA Region 2 Division of Environmental Planning and Protection; Michael Barnes, Chesapeake Research Consortium/CBP Office; Greg Barranco, EPA Region 3 CBP Office; Richard Batiuk, EPA Region 3 CBP Office; Benita Best-Wong, EPA Office of Water; Carin Bisland, EPA Region 3 CBP Office; Ross Brennan, EPA Office of Water; Kevin Bricke, EPA Region 2 Division of Environmental Planning and Protection; Chris Brosch, University of Maryland/CBP Office; Brian Burch, EPA Region 3 CBP Office; Jon Capacasa, EPA Region 3 WPD; Ann Carkhuff, EPA Region 3 WPD; Peter Claggett, U.S. Geological

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**Members of the Chesapeake Bay Program's Water Quality Goal Implementation Team gather in Lancaster, Pennsylvania, in April 2009 to discuss development of the Chesapeake Bay TMDL.**

# SECTION 1. INTRODUCTION

This document establishes total maximum daily loads (TMDLs) for nitrogen, phosphorus, and sediment for the Chesapeake Bay and its tidal tributaries and embayments as required by section 303(d) of the Clean Water Act (CWA) and its implementing regulations at Title 40 of the *Code of Federal Regulations* (CFR) section 130.7. This TMDL represents the culmination of decades of collaboration among many partners and stakeholders and is the result of an analysis of water quality pollution and its solution on an unprecedented geographic, scientific, programmatic, and political scale. While all TMDLs are unique, this TMDL is distinguished by the magnitude of the watershed it addresses and the wealth of science synthesized, data developed, and analyses conducted over the course of the past decades that support its conclusions.

In an effort to keep the Chesapeake Bay TMDL (Bay TMDL) document as clear and succinct as possible, discussion of the technical analyses and modeling that support the pollutant allocations are reasonably summarized in nature with links provided to the more detailed technical support documentation. Because of the large size of the watershed and the many individual sources, load allocations (LAs) and wasteload allocations (WLAs) summarized in Section 9 are presented in greater detail in supporting appendices.

This document is organized into 11 sections as follows:

- Section 1: Clean Water Act and regulatory, statutory, and historical background of the Chesapeake Bay TMDL
- Section 2: Description of the Chesapeake Bay watershed, the Bay, and its impaired segments
- Section 3: The jurisdictions' Chesapeake Bay water quality standards
- Section 4: The major sources of nutrients and sediment in the Bay, its watershed, and its airshed
- Section 5: The modeling tools used to develop the WLAs and LAs
- Section 6: How the TMDL was developed, including the allocation methodology and related considerations
- Section 7: Discussion of reasonable assurance, Bay TMDL implementation, and the Bay TMDL accountability framework
- Section 8: The evaluation of jurisdictions' Watershed Implementation Plans
- Section 9: The individual nitrogen, phosphorus, and sediment TMDLs for each of the 92 Bay tidal segments
- Section 10: Adaptive management approach to Bay TMDL implementation
- Section 11: Documentation of public participation, comments, and responses

This document also contains three additional sections providing: a list of references (Section 12), a glossary (Section 13), and a list of abbreviations (Section 14) and 24 Appendices.

Additional supporting information that is not part of this document or its appendices, can be found as follows:

- Technical documentation for each of the Chesapeake Bay TMDL models and supporting tools—Bay airshed, land change, Scenario Builder, SPARROW, Bay watershed, Bay water quality and sediment transport, oyster filter feeder, and menhaden filter feeder—are provided via URL links in Section 5.
- Access to each of the jurisdictions' final Phase I Watershed Implementation Plans (WIPs) is provided via URL in Section 7. The WIPs are part of the accountability framework meant to implement the Bay TMDL, but they are not an element of the Bay TMDL itself. EPA reviewed the Phase I WIPs as part of the information used to inform its allocation decisions.
- Publicly accessible agreements, documents, reports, papers, meeting summaries, correspondence, and data sets developed during the decades and more recent years leading up to the Chesapeake Bay TMDL, which were instrumental in setting the scientific, programmatic, policy, and legal foundation on which the Bay TMDL is built, are listed in Appendix B with electronic access to all through the provided URLs.

## 1.1 TMDLS AND THE CWA

Section 303(c) of the 1972 Clean Water Act (CWA) requires states, including the District of Columbia, (collectively referred to as jurisdictions) to establish water quality standards (WQS) that identify each waterbody's designated uses and the criteria needed to support those uses. The CWA establishes a rebuttable presumption that all waters can attain beneficial aquatic life uses, i.e., fishable and recreational (i.e., swimmable) uses.

Section 303(d) of the CWA requires states, including the District of Columbia, to develop lists of impaired waters that fail to meet WQS set by jurisdictions even after implementing technology-based and other pollution controls. EPA's regulations for implementing CWA section 303(d) are codified in the Water Quality Planning and Management Regulations at 40 CFR Part 130. The law requires that jurisdictions establish priority rankings and develop TMDLs for waters on the lists of impaired waters (40 CFR 130.7).

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet applicable WQS. A mathematical definition of a TMDL is written as the sum of the individual wasteload allocations (WLAs) for point sources, the load allocation (LAs) for nonpoint sources and natural background, and a margin of safety (MOS)[CWA section 303(d)(1)(C)]:

$$\text{TMDL} = \Sigma WLA + \Sigma LA + MOS$$

where

*WLA* = wasteload allocation, or the portion of the TMDL allocated to existing and/or future point sources.

*LA* = load allocation, or the portion of the TMDL attributed to existing and/or future nonpoint sources and natural background.

*MOS* = margin of safety, or the portion of the TMDL that accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality, such as uncertainty about the relationship between pollutant loads and receiving water quality, which can be provided implicitly by applying conservative analytical assumptions or explicitly by reserving a portion of loading capacity.

The process of calculating and documenting a TMDL involves a number of tasks and—especially for a large, complex, and multijurisdictional waterbody with multiple impairments—can require substantial effort and resources. Major tasks involved in the TMDL development process include the following:

- Characterizing the impaired waterbody and its watershed
- Identifying and inventorying the relevant pollutant source sectors
- Applying the appropriate WQS
- Calculating the loading capacity using appropriate modeling analyses to link pollutant loads to water quality
- Identifying the required source allocations

The Bay TMDL report presents the results of numerous analyses and model simulations designed to calculate the Bay and its tidal tributaries and embayments' pollutant loading capacity and documents the informational elements described above. Because the Chesapeake Bay watershed is so large, and the analysis required for developing the Bay TMDL so extensive, the Chesapeake Bay TMDL and its supporting documentation consists of this report and additional supporting materials in the numerous appendices referenced throughout the report. The Bay TMDL is also supported by an extensive list of significant documents (Appendix B).

## 1.2 HISTORY OF THE CHESAPEAKE BAY TMDL

The Chesapeake Bay watershed has been inhabited for thousands of years, but the population started to increase significantly with the arrival of European settlers in the 1600s. Settlers began clearing forests for timber and to make room for expanding agricultural activities, increasing soil erosion and nutrient delivery to the Bay and its tributaries (Curtin et al. 2001; Rountree et al. 2007). As early as 1900, the oyster population began to decline. Throughout the 20$^{th}$ century, urban development and agricultural activities increased throughout the watershed. In the late 1970s, Maryland Senator Charles Mathias sponsored a congressionally funded, 5-year study to analyze the rapid loss of aquatic life that was affecting the Bay. That study identified excess nitrogen and phosphorus pollution as the main source of the Bay's degradation (USEPA 1982, 1983a, 1983b, 1983c, 1983d).

### *1.2.1 Regulatory and Management Initiatives*

In response to the Bay's decline, various regulatory and management initiatives have been undertaken aimed at Bay restoration, ranging from cooperative agreements among surrounding jurisdictions to new regulatory programs and policies. Through the years, the agreements and alliances have become more formalized and inclusive to address the multitude of factors

contributing to the deterioration in Chesapeake Bay water quality. The following paragraphs outline the major policy, legislative, and programmatic events that have led to the development of the Bay TMDL, including the management agreements and statutory and regulatory requirements that form the underpinning of the Bay TMDL.

### 1983 Chesapeake Bay Agreement

In 1983 the governors of Maryland, Virginia, and Pennsylvania; the mayor of the District of Columbia; the chairman of the Chesapeake Bay Commission; and EPA's Administrator signed the first Chesapeake Bay Agreement. In that agreement, the signatories acknowledged the decline in living resources of the Chesapeake Bay and agreed to establish the Chesapeake Executive Council (CEC) to "assess and oversee the implementation of coordinated plans to improve and protect the water quality and living resources of the Chesapeake Bay estuarine systems" (Chesapeake Bay Partnership 1983).

### 1987 Chesapeake Bay Agreement

Faced with the need to take a more comprehensive and coordinated approach to restoring water quality and living resources of the Chesapeake Bay, the signatories to the 1983 agreement entered into the 1987 Chesapeake Bay Agreement (CEC 1987). The 1987 Chesapeake Bay Agreement set priority goals and commitments, of which a key goal was to "reduce and control point and nonpoint sources of pollution to attain the water quality condition necessary to support the living resources of the Bay." To achieve that goal, signatories to the 1987 Bay Agreement committed to reduce the controllable nitrogen and phosphorus loads delivered to the mainstem of the Chesapeake Bay by 40 percent by 2000 and to develop a Bay-wide implementation strategy to achieve those reductions (CEC 1987).

### CWA Section 117 and the Chesapeake Bay Program (CBP)

In the 1987 amendments to the CWA, Congress—in section 117—authorized the formation and funding of the Chesapeake Bay Program (CBP) within EPA Region 3. Congress directed the CBP to collect and disseminate information related to the environmental quality of the Bay, to "coordinate state and federal efforts to improve Bay water quality, to evaluate sediment impacts on the Bay, and to determine the impact of natural and human-induced environmental changes on the living resources of the Bay."[1]

### 1991 Reevaluation

A 1991 reevaluation of progress made toward achievement of the 1987 Bay Agreement's 40 percent nutrient reduction goal led to a detailed quantification of the original narrative goal. Each major river basin by jurisdiction received a "tributary nutrient load allocation" as a "40% controllable load reduction" for both nitrogen and phosphorus as the principal outcome of the reevaluation (Secretary Robert Perciasepe 1992). The 1991 reevaluation also introduced several concepts still applicable in the Bay TMDL: tributary strategies (WIPs), limit of technology (everything by everyone everywhere or E3 scenario), recognition of air deposition (air load allocation to tidal surface waters), and geographic-based allocations (relative effectiveness-based allocation methodology).

[1] Clean Water Act section 117 (33 United States Code [U.S.C.] 1267).

### 1992 Amendments to the Chesapeake Bay Agreement

The 1991 reevaluation led to several amendments to the 1987 Chesapeake Bay Agreement in 1992, including an increased focus on the importance of the tributaries in the Bay's restoration. The parties to the 1987 Chesapeake Bay Agreement were to begin by 1993 to develop and implement tributary-specific strategies to meet mainstem nutrient reduction goals, to improve water quality, and to restore living resources to the mainstem and tributaries (CEC 1992). The amendments also established a goal of expanding the distribution of submerged aquatic vegetation (SAV) as an initial measure of progress toward the water quality and living resource goals of the 1987 Agreement.

### 1997 Reevaluation

In 1997 the CBP conducted a year-long evaluation to assess what progress had been made toward the goal set in the 1987 Chesapeake Bay Agreement of a 40 percent reduction by 2000 in nitrogen and phosphorus delivered to the Bay (CEC 1997). The 1997 reevaluation found that between 1985 and 1996 phosphorus loads delivered to the Bay declined by 6 million pounds annually, and nitrogen loads delivered to the Bay declined by 29 million pounds annually. By 1996 phosphorus loads from wastewater dischargers had been reduced by 51 percent in the participating jurisdictions as a result of implementing effluent standards, upgrading wastewater treatment plants, and banning phosphate laundry detergents. Wastewater nitrogen loads were reduced by 15 percent by implementing biological nutrient removal at some major municipal wastewater treatment facilities and by upgrading certain industrial wastewater treatment facilities. Implementation of nutrient reduction best management practices (BMPs) reduced nonpoint source loadings of nitrogen and phosphorus to the Bay by 7 and 9 percent, respectively. There was no clear trend in Bay dissolved oxygen (DO) levels, however. Although progress was made, the 1997 reevaluation report stated, "we must accelerate our efforts to close the gap on the year 2000 goal, maintain those reduced loading levels into the future and if necessary adjust the nutrient goals to help us achieve the water quality improvements needed to sustain living resources in the Bay" (CBP 1997).

### 1999 Integration of Cooperative and Statutory Programs

In September 1999, senior water quality program managers representing the Bay watershed jurisdictions and EPA outlined the *Process for Integrating the Cooperative and Statutory Programs of the Chesapeake Bay and its Tributaries—Continuing the Watershed Partnership to Restore the Chesapeake Bay* (CBP 1999). That consensus document laid the groundwork for the water quality goals and commitments within the Chesapeake 2000 Agreement. A decade in advance, it set the partnership on a course that culminated in the Bay TMDL.

### Chesapeake 2000 Agreement

In June 2000 the governors of Maryland, Virginia, and Pennsylvania; the mayor of the District of Columbia; the Administrator of EPA; and the chairman of the Chesapeake Bay Commission signed the Chesapeake 2000 Agreement (CEC 2000). To meet the goal of "achieving and maintaining the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health," the signatories committed to specific actions, including:

"Continue to achieve and maintain the 40 percent nutrient reduction goal agreed to in 1987.

By 2010, correct nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act. In order to achieve this:

1. By 2001, define the water quality conditions necessary to protect aquatic living resources and then assign load reductions for nitrogen and phosphorus to each major tributary;
2. By 2001, using a process parallel to that established for nutrients, determine the sediment load reductions necessary to achieve the water quality conditions that protect aquatic living resources, and assign load reductions for sediment to each major tributary;
3. By 2002, complete a public process to develop and begin implementation of revised Tributary Strategies to achieve and maintain the assigned loading goals;
4. By 2003, jurisdictions with tidal waters use their best efforts to adopt new or revised WQS consistent with the defined water quality conditions. Once adopted by the jurisdictions, EPA will expeditiously review the new or revised standards, which are used as the basis for removing the Bay and its tidal rivers from the list of impaired waters; and
5. By 2003, work with the Susquehanna River Basin Commission and others to adopt and begin implementing strategies that prevent the loss of the sediment retention capabilities of the lower Susquehanna River dams."

### 2000 Six-Jurisdiction Memorandum of Understanding

In the fall of 2000, EPA, Delaware, the District of Columbia, Maryland, New York, Pennsylvania, and Virginia signed a Memorandum of Understanding (MOU) (Chesapeake Bay Watershed Partners 2000), with West Virginia joining as a signatory in June 2002, agreeing to the following:

- Work cooperatively to achieve the nutrient and sediment reduction targets necessary to achieve the goals of a clean Chesapeake Bay by 2010, thereby allowing the Chesapeake Bay and its tidal tributaries to be removed from the list of impaired waters.
- Provide for an inclusive, open and comprehensive public participation process.
- Collaborate on the development and use of innovative measures such as effluent trading, cooperative implementation mechanisms, and expanded interstate agreements to achieve the necessary reductions.

The signatories also agreed to report annually on progress toward achieving the goals of the agreement.

### 2003 Nutrient and Sediment Cap Load Allocations

In 2003 EPA and its seven watershed jurisdictional partners established nitrogen, phosphorus, and sediment cap loads based on Bay water quality model projections of attainment of the then EPA-proposed dissolved oxygen water quality criteria under long-term average hydrologic conditions (Secretary Tayloe Murphy 2003). Reaching those cap loads was expected to eliminate

the summer no-oxygen conditions in the deep waters of the Bay and excessive algal blooms throughout the Bay, tidal tributaries and embayments (USEPA 2003c).

EPA and its watershed jurisdiction partners allocated the nitrogen and phosphorus cap loads among the major river basins by jurisdiction. Those jurisdictions with the highest impact on Bay water quality were assigned the highest nutrient reductions, while jurisdictions without tidal waters received less stringent reductions because they would not realize a direct benefit from the improved water quality conditions in the Bay (USEPA 2003c). Sediment allocations were based on the phosphorus-equivalent allocations to each major river basin by jurisdiction (USEPA 2003c).

Although not original signatories of the Chesapeake 2000 Agreement, New York, Delaware, and West Virginia signed on as partners in implementing the cap loads; thus, all seven Bay watershed jurisdictions were assigned allocations (Chesapeake Bay Watershed Partners 2000; USEPA 2003c). The final total basinwide cap loads agreed to by EPA and the seven watershed jurisdictions were 175 million pounds of nitrogen per year and 12.8 million pounds of phosphorus per year delivered to the tidal waters of the Bay (USEPA 2003c). The basinwide upland sediment cap load was 4.15 million tons per year (USEPA 2003c).

### 2004–2006 Tributary Strategies

To achieve the nitrogen, phosphorus, and sediment cap loads, the seven watershed jurisdictions developed what became known as the Chesapeake Bay Tributary Strategies (Table 1-1) (Secretary Tayloe Murphy 2003). The tributary strategies outlined river basin-specific implementation activities to reduce nitrogen, phosphorus, and sediment pollutant loads from point and nonpoint sources sufficient to remove the Chesapeake Bay and its tidal tributaries and embayments from the Bay jurisdictions' respective impaired waters lists. Many of the policies and procedures used in developing the Chesapeake Bay TMDL originated with the development of the 2003 nutrient and sediment cap loads and subsequent development of tributary strategies.

**Table 1-1. URLs for accessing the seven Chesapeake Bay watershed jurisdictions' tributary strategies**

| Jurisdiction | Tributary strategy URL link |
|---|---|
| Delaware | http://www.chesapeakebay.net/watershedimplementationplantools.aspx?menuitem=52044 |
| District of Columbia | http://www.chesapeakebay.net/watershedimplementationplantools.aspx?menuitem=52044 |
| Maryland | http://www.dnr.state.md.us/bay/tribstrat/implementation_plan.html |
| New York | http://www.dec.ny.gov/docs/water_pdf/cbaystratfinal.pdf |
| Pennsylvania | http://www.chesapeakebay.net/watershedimplementationplantools.aspx?menuitem=52044 |
| Virginia | http://www.chesapeakebay.net/watershedimplementationplantools.aspx?menuitem=52044 |
| West Virginia | http://www.wvca.us/bay/files/bay_documents/8_9657_WV_Potomac_Tributary_Strategy_FINAL_from_web.pdf |

#### 2004–2005 Jurisdiction Adoption of Chesapeake Bay Water Quality Standards

In continued efforts to coordinate activities to address nitrogen, phosphorus, and sediment-based pollution in the Bay, the tidal jurisdictions of Maryland, Virginia, Delaware, and the District of Columbia adopted into their respective WQS regulations the EPA-published Chesapeake Bay water quality criteria for dissolved oxygen, water clarity, SAV, and chlorophyll *a*, along with criteria attainment assessment procedures and refined tidal water designated uses (for details, see Section 3) (USEPA 2003a, 2003d). EPA approved those four jurisdictions' WQS regulations modifications pursuant to CWA section 303(c).

#### 2007 Reevaluation

Secretary Tayloe Murphy's 2003 memorandum summarized the comprehensive set of agreements made by Bay watershed partners with regard to cap loads for nitrogen, phosphorus, and sediment; new Bay-wide and local SAV restoration goals; and a commitment to reevaluate the allocations in 2007 (Secretary Tayloe Murphy 2003). The initiation of that reevaluation at a partnership sponsored workshop in September 2005 laid the institutional groundwork for the collaborative work on the Bay TMDL (Chesapeake Bay Reevaluation Steering Committee 2005).

EPA and the seven watershed jurisdictions reevaluated the nutrient and sediment cap loads in 2007, in response to the four Bay jurisdictions revising their WQS regulations for the Chesapeake Bay, its tidal tributaries and embayments in 2004-2005 (Secretary Tayloe Murphy 2003). The 2007 reevaluation found that sufficient progress had not been made toward improving water quality to a level that indicated the mainstem Chesapeake Bay and its tidal tributaries and embayments were no longer impaired by nitrogen, phosphorus, and sediment pollution (Chesapeake Bay Reevaluation Steering Committee 2005).

### *1.2.2 Partnership Commitment to Develop the Chesapeake Bay TMDL*

Throughout the Bay TMDL development process, EPA has worked in close and open partnership with all seven watershed jurisdictions, sharing decision making with the jurisdictions via the CBP structure described in Section 1.3. While EPA established the Bay TMDL, the seven watershed jurisdictions were essential partners in the initiative, providing critical input and participating in deliberations and making key decisions affecting the development process. The seven Bay watershed jurisdictions and EPA had been building the foundation for the Chesapeake Bay TMDL since signing the Chesapeake 2000 Agreement, which laid out the steps necessary to put in place an appropriate framework for a future Bay TMDL, including consistent jurisdictional Chesapeake Bay WQS (CEC 2000).

From the September 2005 reevaluation workshop to the publication of the Bay TMDL in December 2010, the seven watershed jurisdictions were actively involved in developing the Bay TMDL through participation in the CBP's Principals' Staff Committee (PSC), Water Quality Goal Implementation Team (WQGIT), and other decision-making committees, teams, and technical workgroups (see Section 1.3.1). The full records of the meetings and conference calls of those committees, teams, and workgroups are accessible via the Internet—see Appendix C.

At the October 1, 2007 meeting of the PSC, the seven watershed jurisdictions and EPA reached consensus that EPA would establish the Bay TMDL on behalf of the seven jurisdictions with a target date of 2025 when all necessary pollution control measures would be in place (CBP PSC 2007). Consensus within the Principals' Staff Committee means that all parties present have either agreed on this as a course of action and/or that no party objected to it. Table 1-2 summarizes that and the other Bay TMDL-relevant consensus agreements reached by the partners during that meeting.

**Table 1-2. Summary of Chesapeake Bay TMDL relevant actions agreed to by the CBP's Principals' Staff Committee during its October 1, 2007, meeting**

- The Bay watershed TMDLs will be developed jointly between the six Bay watershed states, the District, and EPA and then established by EPA.
- The Water Quality Steering Committee (WQSC) will draft nutrient and sediment cap load allocations by tributary basin by jurisdiction, and the PSC will formally adopt these allocations.
- The watershed states and the District would have responsibility for further assigning loads — WLAs and LAs—to sources consistent with EPA regulations and guidance.
- These state/District suballocations (WLA/LA) would become part of the overall Bay watershed TMDLs report.
- The final publication would contain all the required documentation supporting the EPA Bay watershed TMDLs in a single, integrated publication with extensive appendices.
- EPA will provide the technical resources/analyses required to support development of the Bay watershed TMDLs through the CBP Office staff and EPA-funded contractor support.
- The Bay watershed TMDLs must be completed and established by EPA no later than May 1, 2011.
- The CBP partners will engage stakeholders and the public in a more extensive structured dialogue about the tributary strategy implementation challenges before us.
- The CBP partners will focus on getting the programs in place by 2010 that we believe are required to achieve our water quality goals.
- The CBP partnership's public announcement of initiation of work on the Bay watershed TMDLs will occur following the states' submission and EPA approval of the 2008 303(d) lists in the spring 2008 time frame.
- Eight principles will guide the reevaluation efforts by the WQSC and its workgroups (see Attachment A for more detailed version):
  - Shared urgency to restore the Bay;
  - Clear communication and common message;
  - Focus and accelerate implementation (do no harm);
  - Engage the public about the implementation challenge;
  - Legal obligations will be met;
  - Improving and applying the latest science;
  - Flexibility of the sub-allocations within the major basins; and
  - Keep healthy waters healthy.
- The WQSC will proceed forward with the responsibility for carrying out the necessary preparation work following these eight guiding principles.
- The state/EPA Reevaluation Technical Workgroup (RTWG) will be reconvened and operate under the direction of the WQSC.
- The RTWG was charged with responsibility for resolving the existing technical issues in light of the desire to accelerate implementation at all scales. The WQSC will convene a parallel Implementation Workgroup and charge this group with the responsibility for ensuring that the reevaluation and TMDL development process results in acceleration of ongoing tributary strategy implementation.

Source: CBP PSC 2007

### 1.2.3 President's Chesapeake Bay Executive Order

On May 12, 2009, President Barack Obama issued the Chesapeake Bay Protection and Restoration Executive Order 13508, which calls for the federal government to lead a renewed effort to restore and protect the Chesapeake Bay and its watershed. Critical among its directives were:

- Establish a Federal Leadership Committee to oversee the development and coordination of reporting, data management and other activities by agencies involved in Bay restoration.
- Require involved agencies to prepare and submit reports with recommendations on a wide range of Bay issues (EPA-HQ-OW-2009-0761; FRL-8978-8).
- Require the Federal Leadership Committee to develop a *Strategy for Protecting and Restoring the Chesapeake Bay* by May 2010 (http://executiveorder.chesapeakebay.net/).
- Require the Federal Leadership Committee to publish an annual *Chesapeake Bay Action Plan* describing how federal funding proposed in the President's budget will be used to protect and restore the Chesapeake Bay during the upcoming fiscal year.
- Require federal agencies to consult extensively with Bay watershed jurisdictions in preparing their reports.

Pursuant to the Executive Order, on May 12, 2010, the Federal Leadership Committee—led by the EPA Administrator and secretaries from the Departments of Agriculture, Commerce, Defense, Homeland Security, Interior, Transportation, and others—issued its coordinated strategy for restoring the Chesapeake Bay (FLCCB 2010). That strategy sets measurable goals for improving environmental conditions in the Bay for the following:

- Clean water
- Habitat
- Fish and wildlife
- Land and public access

Other supporting strategies address citizen stewardship, climate change, science, and implementation and accountability. A key element of the approach for meeting water quality goals was the development of this TMDL for the Chesapeake Bay (FLCCB 2010).

Parallel to the issuance of the Executive Order, the jurisdictions and the federal government committed to implement all necessary measures for restoring water quality in the Bay by 2025 and to meet specific milestones every 2 years (FRL-8955-4; Clean Water Act section 303(d): Preliminary Notice of Total Maximum Daily Load (TMDL) Development for the Chesapeake Bay). To that end, EPA is developing an accountability framework to guide the overall restoration effort and to link it to implementation of the Chesapeake Bay TMDL. The accountability framework, which is discussed in more detail in Section 7, includes four elements:

- Watershed Implementation Plans (WIPs)
- Two-year milestones to demonstrate restoration progress
- EPA's commitment to track and assess progress

- Federal actions if the Bay watershed jurisdictions fail to meet expectations such as developing sufficient WIPs, effectively implementing their WIPs, and/or fulfilling their 2-year milestones

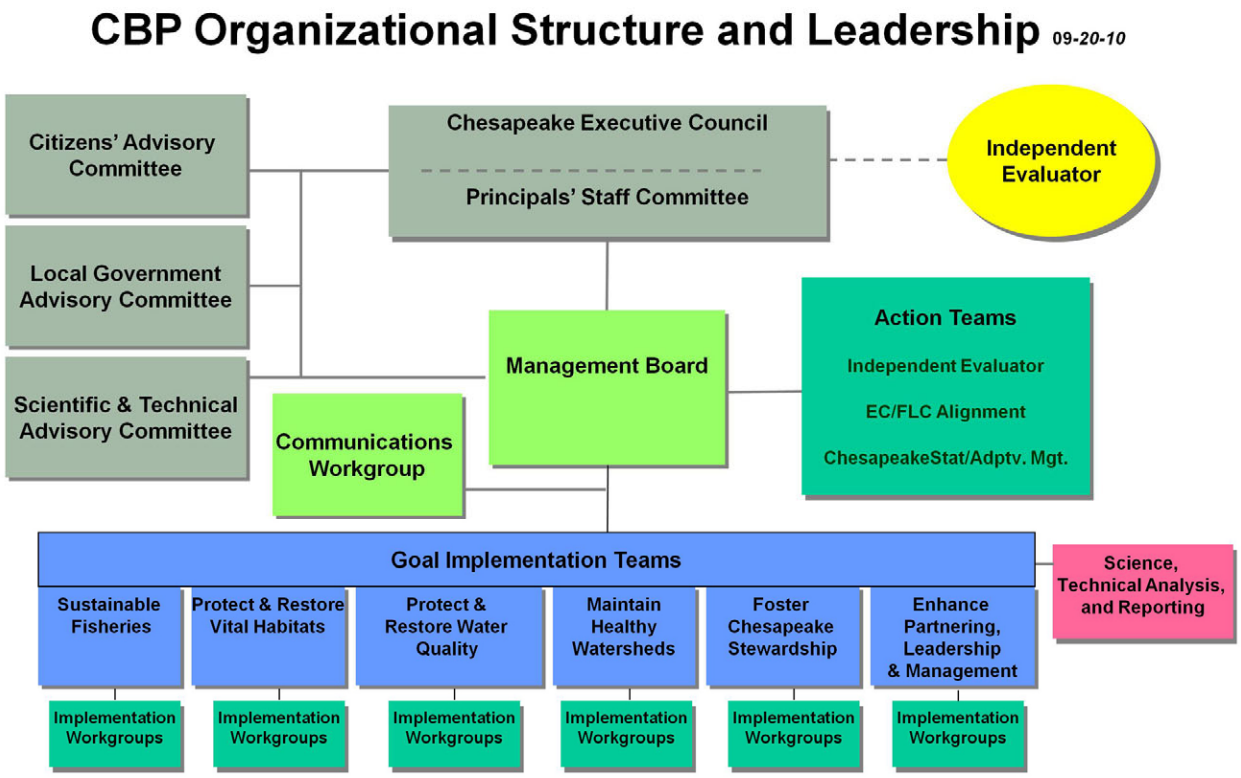
## 1.3 BAY TMDL PROCESS, PARTNER COORDINATION AND RESPONSIBILITIES

EPA Region 3 is the lead federal office responsible for developing the Chesapeake Bay TMDL, with the Water Protection Division (WPD) having the lead responsibility within the Regional Office. In developing this TMDL, WPD coordinated efforts with the Chesapeake Bay Program Office, Air Protection Division, Office of Regional Counsel, Office of State and Congressional Relations, Office of Public Affairs, and Office of the Regional Administrator (all within EPA Region 3), EPA Region 2 (Division of Environmental Planning and Restoration and Office of the Regional Administrator), and EPA Headquarters (Office of Water, Office of General Counsel, Office of Air and Radiation, and Office of the Administrator). Throughout the Bay TMDL development process, EPA worked in close and open partnership with all seven watershed jurisdictions, numerous federal agency partners, and a diverse array of other partners and stakeholders through the CBP partnership. This section describes the different elements of the CBP organizational structure and provides additional descriptions of the roles and responsibilities of the various entities and stakeholders involved in developing the Chesapeake Bay TMDL.

### *1.3.1 CBP Partnership and Organizational Structure*

The CBP is a unique regional partnership that includes Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission, EPA, federal agencies, and participating advisory groups. The headwater states of Delaware, New York, and West Virginia participate as full partners on issues related to water quality. Each of the CBP partners agrees to use its own resources to implement projects and activities that advance Bay and watershed restoration.

The partnership defines its collective actions through formal, voluntary agreements and provides general policy direction through consensus documents, typically called directives. The CBP works through a series of Goal Implementation Teams with oversight provided by the CBP's Management Board. Extensive documentation of the CBP structure and governance is provided in *Chesapeake Bay Program Governance—Managing the Partnership for a Restored and Protected Watershed and Bay* (CBP 2009). Figure 1-1 shows the CBP organizational chart.




Source: CBP 2009

**Figure 1-1. CBP's organizational structure.**

## Chesapeake Executive Council

The top executive of each of the signatories of the Chesapeake 2000 Agreement (state governors, the District of Columbia mayor, EPA Administrator, and Chesapeake Bay Commission Chair), form the Chesapeake Executive Council (CEC), which meets annually to set basinwide policies and the future directions for the CBP. Delaware, New York, and West Virginia participate in CEC meetings and have full input status on all water quality-related matters. Principals' Staff Committee (PSC) members serve as advisors to their respective CEC members. The CEC has played a pivotal role in developing the Bay TMDL by signing the Chesapeake 2000 Agreement and subsequent directives and by setting the partnership on a well-defined, 10-year path directly supporting development of the Bay TMDL (CEC 2000, 2003, 2005).

## Federal Leadership Committee

To bring the full weight of the federal government to address the Chesapeake's challenges, President Obama issued Executive Order 13508 on Chesapeake Bay Protection and Restoration and established the Federal Leadership Committee, which is chaired by the Administrator of the U.S. Environmental Protection Agency and includes senior representatives from the departments of Agriculture, Commerce, Defense, Homeland Security, Interior, and Transportation.

### Principals' Staff Committee

The Principals' Staff Committee (PSC) provided policy and programmatic direction to the Management Board on the development and adoption of the Chesapeake Bay nutrient and sediment targets and allocations for the Bay TMDL (Figure 1-1). The PSC is composed of cabinet-level representatives from each of the seven watershed jurisdictions, EPA Region 3's Regional Administrator, senior federal agency executives, the Chesapeake Bay Commission executive director, and the director of the CBP Office. The Regional Administrator of EPA Region 3 currently chairs the PSC. The Citizens, Local Governments, and the Scientific and Technical advisory committees all advise the PSC.

### Management Board

PSC members provided policy and program direction to the Management Board which, in turn, provided strategic planning, priority setting, and operational guidance and direction to the Water Quality Goal Implementation Team (WQGIT) during the development of the Bay TMDL (Figure 1-1). The Management Board is composed of senior policy representatives from the seven watershed jurisdictions, the Chesapeake Bay Commission, the nine core federal agency partners,[2] and the chairs of the Citizens, Local Governments, and the Scientific and Technical advisory committees. The Management Board directs and coordinates the efforts of the six Goal Implementation Teams and Action Teams. The director of the CBP Office chairs the Management Board, and the CBP Office provides for the staff to support the work of all the Goal Implementation Teams and workgroups. Staffing for the three advisory committees is supported by EPA through cooperative agreements with nonprofit organizations.

### Water Quality Goal Implementation Team

The WQGIT's purpose is to support efforts to reduce and cap the nitrogen, phosphorus, and sediment loads entering the Bay and to ensure that such reductions are maintained over time. It is composed of the members of the former Water Quality Steering Committee and the former Nutrient Subcommittee. The WQGIT provided advice and guidance to EPA related to the draft target loads and allocations before they were brought to the PSC. The WQGIT consists of senior water program managers from each of the seven Bay watershed jurisdictions, EPA Headquarters and Regions 2 and 3, the Chesapeake Bay Commission, the Susquehanna River Basin Commission, and the Interstate Commission on the Potomac River Basin. The WQGIT provided technical direction to the Watershed Technical, Agriculture, Forestry, Wastewater Treatment, Sediment, and Urban Stormwater workgroups.

### Watershed Technical Workgroup

The Watershed Technical Workgroup was created to provide a forum for communication among the Bay watershed jurisdictions and other CBP participants on technical issues originally related to tributary strategy development, tracking and reporting. Members of the Watershed Technical Workgroup include technical staff and mid-level managers from the seven watershed jurisdictions, EPA, and point source and environmental stakeholder groups. For the Chesapeake

[2] The Natural Resources Conservation Service, U.S. Forest Service, National Oceanic and Atmospheric Administration, U.S. Geological Survey, National Park Service, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Department of Defense, and EPA.

Bay TMDL, the workgroup provided review and oversight in regards to application of the Bay Watershed Model.

### Pollutant Source Workgroups

The Agricultural Workgroup coordinated and evaluated agricultural nutrient and sediment reduction measures throughout the jurisdictions and resolved issues related to tracking, reporting, and crediting conservation practices.

The Forestry Workgroup provided information on the effectiveness of different riparian forest buffer restoration and other forest management practices.

The Wastewater Treatment Workgroup provided a formal means of communication among federal agencies, state agencies/jurisdictions, and wastewater treatment facility owner/operators.

The Sediment Workgroup provided technical and policy-related assistance to the CBP partners in setting the sediment allocations.

The Urban Stormwater Workgroup provided input related to all aspects of stormwater nutrient and sediment loads and management practices.

### Science, Technical Analysis, and Reporting Team—Criteria Assessment Protocols Workgroup

The Criteria Assessment Protocols Workgroup had the lead responsibility for ensuring coordinated assessment of all Chesapeake Bay, tidal tributary and embayment waters related to the four Bay jurisdictions' listing and delisting under CWA section 303(d). The workgroup also had the lead in developing, reviewing, and recommending to the WQGIT amendments to the original 2003 Chesapeake Bay water quality criteria published by EPA.

### Science, Technical Analysis, and Reporting Team—Modeling Workgroup

The Modeling Workgroup, formerly the Modeling Subcommittee and now under the Science, Technical Analysis, and Reporting (STAR) team, oversaw the development, calibration, verification, and management application of the suite of computer-based Bay models that supported the development of the Bay TMDL. The models allowed managers to estimate the pollutant load reductions needed to achieve WQS and to assess the potential of different management scenarios to achieve the needed pollutant load reductions.

### Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) is composed of scientists representing a diverse range of disciplines from federal agencies and academic institutions in the seven watershed jurisdictions. STAC provides scientific and technical guidance and independent scientific peer review to the CBP on measures to restore and protect the Chesapeake Bay. STAC activities related to the Bay TMDL included independent scientific peer reviews of all the Bay models (watershed, land change, estuarine water quality, estuarine sediment transport, estuarine filter feeder), Bay criteria assessment procedures, and land use data, and reviewing and commenting on the draft Bay TMDL.

### Local Governments Advisory Committee

The Local Governments Advisory Committee (LGAC) is a body of locally elected officials appointed by the governors of Maryland, Pennsylvania, Virginia, and the mayor of the District of Columbia. The LGAC was established to promote the role of local governments in Bay restoration efforts and develop strategies that ultimately broaden local government participation in the CBP. The LGAC was directly involved in developing the Bay TMDL in the following ways: ensured the direct involvement of local elected officials in the decision-making processes, helped establish the local Watershed Implementation Plan (WIP) pilots in 2010 (before development of the Phase II WIPs starting in 2011), and helped inform the thousands of local governments across the watershed about the Bay TMDL.

### Citizen's Advisory Committee

The Citizens Advisory Committee (CAC) provides advice to the CEC, the PSC, the Management Board, and all the Goal Implementation Teams as needed in implementing the Chesapeake Bay Agreement. The CAC directly assisted the Bay TMDL development process by providing detailed recommendations on how to engage the nongovernmental components of the larger Bay watershed community and placing a strong focus on ensuring full accountability during the development and throughout the long-term implementation of the Bay TMDL.

Appendix A provides the membership lists of all the above described committees, teams, and workgroups at the time of publication of the Bay TMDL, fully acknowledging their individual and collective contributions.

## 1.4 LEGAL FRAMEWORK FOR THE CHESAPEAKE BAY TMDL

### *1.4.1 What is a TMDL?*

As discussed more fully in Section 1.1, a TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet applicable WQS. Allocations to point sources are called wasteload allocations or WLAs, while allocations to nonpoint sources are called load allocations or LAs. A TMDL is the sum of the WLAs (for point sources), LAs (for nonpoint sources and natural background) (40 CFR 130.2), and a margin of safety (CWA section 303(d)(1)(C)). Section 303(d) requires that TMDLs be established for impaired waterbodies "at a level necessary to implement the applicable [WQS]."[3]

TMDLs are "primarily informational tools" that "serve as a link in an implementation chain that includes federally regulated point source controls, state or local plans for point and nonpoint source pollutant reduction, and assessment of the impact of such measures on water quality, all to the end of attaining water quality goals for the nation's waters."[4] Recognizing a TMDL's role as a vital link in the implementation chain, federal regulations require that effluent limits in NPDES permits be "consistent with the assumptions and requirements of any available WLA" in an approved TMDL.[5]

[3] 33 U.S.C. 1313(d)(1)(C).
[4] Pronsolino v. Nastri, 291 F.3d 1123, 1129 (9th Cir. 2002).
[5] 40 CFR 122.44(d)(1)(vii)(B).

In addition, before EPA establishes or approves a TMDL that allocates pollutant loads to both point and nonpoint sources, it determines whether there is reasonable assurance that the nonpoint source LAs will, in fact, be achieved and WQS will be attained (USEPA 1991b). If the reductions embodied in LAs are not fully achieved, the collective reductions from point and nonpoint sources will not result in attainment of the WQS.

The Bay TMDL will be implemented using an accountability framework that includes the jurisdictions' WIPs, 2-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal actions if the Bay jurisdictions do not meet their commitments. The accountability framework is being established, in part, to demonstrate that the Bay TMDL is supported by reasonable assurance. The accountability framework is also being established pursuant to CWA section 117(g)(1). Section 117(g) of the CWA directs the EPA Administrator to "ensure that management plans are developed and implementation is begun...to achieve and maintain...the nutrient goals of the Chesapeake Bay Agreement for the quantity of nitrogen and phosphorus entering the Chesapeake Bay and its watershed, [and] the water quality requirements necessary to restore living resources in the Chesapeake Bay ecosystem."[6] In addition, Executive Order 13508 directs EPA and other federal agencies to build a new accountability framework that guides local, state, and federal water quality restoration efforts. The accountability framework is designed to help ensure that the Bay's nitrogen, phosphorus, and sediment goals, as embodied in the Chesapeake Bay TMDL, are met. While the accountability framework informs the TMDL, section 303(d) does not require that EPA "approve" the framework *per se*, or the jurisdictions' WIPs that constitute part of that framework.

### 1.4.2 Why is EPA establishing this TMDL?

In 1998, data showed the mainstem and tidal tributary waters of the Chesapeake Bay to be impaired for aquatic life resources. EPA determined that the mainstem and tidal tributary waters of the Chesapeake Bay must be placed on Virginia's section 303(d) list. EPA therefore added the mainstem of the Chesapeake Bay to Virginia's final section 303(d) list. As described in Section 2, each tidal river, tributary, embayment, and other tidal waterbody that is part of the Chesapeake Bay TMDL is included on a jurisdiction's section 303(d) list.

EPA established the Chesapeake Bay TMDL pursuant to a number of existing authorities, including the CWA and its implementing regulations, judicial consent decrees requiring EPA to address certain impaired Chesapeake Bay and tidal tributary and embayment waters, a settlement agreement resolving litigation brought by the Chesapeake Bay Foundation, the 2000 Chesapeake Agreement, and Executive Order 13508. In establishing the Bay TMDL, EPA acted pursuant to the consensus direction of the Chesapeake Executive Council's PSC and in partnership with each of the seven Chesapeake Bay watershed jurisdictions.

The CWA provides EPA with ample authority to establish the Chesapeake Bay TMDL. CWA section 117(g)(1) provides that "[t]he Administrator, in coordination with other members of the [CEC], shall ensure that management plans are developed and implementation is begun by signatories to the Chesapeake Bay Agreement to achieve and maintain [among other things] the

[6] Clean Water Act section 117(g)(1)(A)-(B), 33 U.S.C. 1267(g)(1)(A)-(B).

nutrient goals of the Chesapeake Bay Agreement for the quantity of nitrogen and phosphorus entering the Chesapeake Bay and its watershed [and] the water quality requirements necessary to restore living resources in the Chesapeake Bay ecosystem." Because it establishes the Bay and tidal tributaries' nutrient and sediment loading and allocation targets, the Chesapeake Bay TMDL is itself such a "management plan." In addition, the Bay TMDL's loading and allocation targets both inform and are informed by a larger set of federal and state management plans being developed for the Bay, including the Bay watershed jurisdictions' WIPs and the May 2010 *Strategy for Protecting and Restoring the Chesapeake Bay* (FLCCB 2010).

CWA section 303(d) requires jurisdictions to establish and submit TMDLs to EPA for review. Under certain circumstances, EPA also has the authority to establish TMDLs. The circumstances of this TMDL do not necessarily identify the outer bounds of EPA's authority. However, where – as here – impaired waters have been identified on jurisdictions' section 303(d) lists for many years, where the jurisdictions in question decided not to establish their own TMDLs for those waters, where EPA is establishing a TMDL for those waters at the direction of, and in cooperation with, the jurisdictions in question, and where those waters are part of an interrelated and interstate water system like the Chesapeake Bay that is impaired by pollutant loadings from sources in seven different jurisdictions, CWA section 303(d) authorizes EPA to establish that TMDL[7].

On May 12, 2009, President Barack Obama signed Executive Order 13508—*Chesapeake Bay Protection and Restoration*. The Executive Order's overarching goal is "to protect and restore the health, heritage, natural resources, and social and economic value of the Nation's largest estuarine ecosystem and the natural sustainability of its watershed." The Executive Order says the federal government "should lead this effort" and acknowledges that progress in restoring the Bay "will depend on the support of state and local governments." To that end, the Executive Order directs the lead federal agencies, including EPA, to work in close collaboration with their state partners. To protect and restore the Chesapeake Bay and its tidal tributaries, the President directed EPA to "make full use of its authorities under the [CWA]." In establishing the Bay TMDL, EPA is doing no more—or less—than making full use of its CWA authorities to lead a collaborative and effective federal and state effort to meet the Bay's nutrient and sediment goals.

A number of consent decrees, memoranda of understanding (MOUs), and settlement agreements provide additional support for EPA's decision to establish the Chesapeake Bay TMDL addressing certain waters identified as impaired on the Maryland, Virginia, and the District of Columbia's 1998 section 303(d) lists and on the Delaware 1996 section 303(d) list. EPA established the Chesapeake Bay TMDL consistent with those consent decrees, MOUs, and settlement agreements, described below.

### Virginia–EPA Consent Decree

The American Canoe Association, Inc., and the American Littoral Society filed a complaint against EPA for failing to comply with the CWA, including section 303(d), regarding the TMDL program in the Commonwealth of Virginia. A consent decree signed in 1999 resolved the litigation.[8] The consent decree includes a 12-year schedule for developing TMDLs for impaired

[7] *Dioxin/Organochlorine Center v. Clarke*, 57 F.3d 1517 (9th Cir. 1995); *Scott v. City of Hammond*, 741 F.2d 992 (7th Cir. 1984); *American Canoe Assn. v EPA*, 54 F.Supp.2d 621 (E.D.Va. 1999).
[8] *American Canoe Association v. EPA*, 98cv979 (June 11, 1999).

segments identified on Virginia's 1998 section 303(d) list. The consent decree requires EPA to establish TMDLs for those waters, by May 1, 2011, if Virginia fails to do so according to the established schedule. Virginia has requested that EPA establish TMDLs for the nutrient- and sediment-impaired tidal portions of the Chesapeake Bay and its tributaries and embayments in accordance with the Virginia consent decree schedule (CBP PSC 2007). Table 1-3 provides a list of the Virginia consent decree waters that were addressed by the Chesapeake Bay TMDLs for nitrogen, phosphorus, and sediment.

**Table 1-3. Virginia consent decree (CD) waters impaired for dissolved oxygen (DO) and/or nutrients addressed by the Chesapeake Bay TMDL**

| Waterbody Name | CD Segment ID | Chesapeake Bay Segment ID | CD Impairment |
|---|---|---|---|
| Bailey Bay, Bailey Creek – Tidal | VAP-G03E | JMSTF1 | DO |
| Broad Creek | VAT-G15E | ELIPH, WBEMH,SBEMH, EBEMH | DO |
| Chesapeake Bay Mainstem | Narrative [a] | CB5MH, CB6PH, CB7PH | Nutrients |
| Chesapeake Bay Mainstem | VACB-R01E | CB5MH, CB6PH, CB7PH | DO |
| Elizabeth River – Tidal | Narrative [b] | ELIPH, WBEMH,SBEMH, EBEMH | Nutrients |
| Hungars Creek | VAT-C14R | CB7PH | DO |
| James River – Tidal | Narrative [c] | JMSTF2, JMSTF1, JMSOH, JMSMH, JMSPH | Nutrients |
| King Creek | VAT-F27E | YRKPH | DO |
| Mattaponi River – Tidal | Narrative [d] | MPNTF, MPNOH | Nutrients |
| Messongo Creek | VAT-C10E | POCMH | DO |
| North Branch Onancock Creek | VAT-C11E | CB7PH | DO |
| Pagan River | VAT-G11E | JMSMH | DO |
| Pamunkey River – Tidal | Narrative [e] | PMKTF, PMKOH | Nutrients |
| Queen Creek | VAT-F26E | YRKMH | DO |
| Rappahannock River | Narrative [f] | RPPMH | Nutrients |
| Rappahannock River | VAP-E25E | RPPMH | Nutrients |
| Rappahannock River | VAP-E25E | RPPMH | DO |
| Rappahannock River | VAP-E26E | RPPMH | Nutrients |
| Rappahannock River | VAP-E26E | RPPMH | DO |
| Thalia Creek | VAT-C08E | LYNPH | DO |
| Williams Creek | VAN-A30E | POTMH | DO |
| York River | Narrative [g] | YRKMH, YRKPH | Nutrients |
| York River | VAT-F27E | YRKPH | DO |

Source: *American Canoe Association v. EPA*, 98cv979 (June 11, 1999).
Notes:
a = Chesapeake Bay Mainstem (VACB-R01E) impaired for nutrients
b = Elizabeth River (VAT-G15E) impaired for DO, nutrients
c = James River (VAP-G01E, VAP-G03E, VAP-G02E, VAP-G04E, VAP-G11E, and VAP-G15E) impaired for nutrients
d = Mattaponi River (VAP-F24E and VAP-F25E) impaired for nutrients
e = Pamunkey River (VAP-F13E and VAP-F14E) impaired for DO, nutrients
f = Rappahannock River (VAP-E24E) impaired for DO
g = York River (VAT-F26E) impaired for nutrients

### District of Columbia–EPA Consent Decree

In 1998 Kingman Park Civic Association and others filed a similar suit against EPA.[9] The lawsuit was settled through the entry of a consent decree requiring EPA to, among other things, establish TMDLs for the District of Columbia's portions of the tidal Potomac and tidal Anacostia rivers if not established by the District of Columbia by a certain date.

The impairment of the District of Columbia's portion of the upper tidal Potomac River by low pH is directly related to the Chesapeake Bay water quality impairments because the low pH is a result of excess nutrients causing algal blooms in the tidal river. Establishing a tidal Potomac River pH TMDL is directly linked to establishing the Chesapeake Bay TMDL because of their common impairing pollutants (nitrogen and phosphorus) and the hydrologic connection between the District's portion of the tidal Potomac River and the Chesapeake Bay. EPA and the Kingman Park plaintiffs jointly sought, and received on February 12, 2008, a formal extension of the District of Columbia TMDL Consent Decree so that EPA could complete the Potomac River pH TMDL on the same schedule as the Chesapeake Bay TMDL.[10] The District of Columbia requested that EPA establish the pH TMDL for the District's portion of the tidal Potomac River (CBP PSC 2007). Table 1-4 provides a list of the District's consent decree waters that were addressed by the Chesapeake Bay TMDLs for nitrogen, phosphorus, and sediment.

In addition, Anacostia Riverkeeper and Friends of the Earth filed suit against EPA challenging more than 300 TMDLs for the District of Columbia, including the Anacostia River TMDLs, because the TMDLs were not expressed as daily loads. On May 25, 2010, the District Court for the District of Columbia ordered the vacatur of the District of Columbia's TMDL for pH for the Washington Ship Channel, with a stay of vacatur until May 31, 2011.[11] With publication of the Bay TMDL, the Washington Ship Channel pH impairment has been addressed and the pH TMDL for the Ship Channel approved by EPA on December 15, 2004 has been superseded.

**Table 1-4. District of Columbia consent decree (CD) waters impaired for pH addressed by the Chesapeake Bay TMDL**

| Waterbody Name | CD Segment ID | Chesapeake Bay Segment ID | CD Impairment |
|---|---|---|---|
| Washington Ship Channel | DCPWC04E_00 | POTTF_DC | pH |
| Middle Potomac River | DCPMS00E | POTTF_DC | pH |

Source: *Kingman Park Civic Association v EPA*, 98cv00758 (June 13, 2000).

### Delaware–EPA Consent Decree

In 1996 the American Littoral Society and the Sierra Club filed a suit against EPA to ensure that TMDLs were developed for waters on Delaware's 1996 section 303(d) list, one of which is a tidal Bay segment (Upper Nanticoke River). The parties entered into a consent decree resolving the lawsuit.[12] The consent decree required EPA to establish TMDLs if Delaware failed to do so within the 10-year TMDL development schedule. Although Delaware established TMDLs for the

[9] *Kingman Park Civic Association v EPA*, 98cv00758 (June 13, 2000).
[10] *Kingman Park Civic Association v. EPA*, 98cv00758 (Order February 12, 2008).
[11] *Anacostia Riverkeeper et al v. Jackson*, 1:2009cv00098 (D.DC)( Mem. and Order May 25, 2010)
[12] *American Littoral Society, et al. v EPA, et al.*, 96cv591 (D.Del. 1997).

one listed tidal Bay segment (DE DNREC 1998), the TMDLs were established to meet prior WQS and are insufficient to attain Chesapeake Bay WQS.

### Maryland–EPA MOU

In 1998 Maryland and EPA Region 3 entered into an MOU that, among other things, established a 10-year schedule for addressing waters on Maryland's 1998 section 303(d) list, with completion by 2008 (MDE 1998). Because of funding constraints, the complexity of some TMDLs, and limited staff resources, Maryland determined that it would not be able to address all 1998 listed waters by 2008. Further, the Chesapeake 2000 Agreement established a goal of meeting water quality standards in the Chesapeake Bay by 2010 (CEC 2000). Many of the waters on Maryland's 1998 section 303(d) list were open waters of the Bay or tidal tributaries and embayments to the Bay. Maryland determined that developing TMDLs for those tidal waters before the deadline established by the MOU, as would be required under the schedule established in 1998, "would undermine the spirit of the agreement" because of a lack of integration between the CBP partnership and Maryland efforts (MDE 2004). Therefore, Maryland decided to postpone development of TMDLs for Maryland's listed Chesapeake Bay and its tidal tributary and embayment waters until the two programs could coordinate efforts.

In September 2004, Maryland and EPA Region 3 entered into a revised MOU that extended the schedule for TMDL development to 13 years (by 2011) (MDE 2004). Although neither Maryland nor EPA is under a consent decree for establishing TMDLs for Maryland waters, the state has requested that EPA develop the TMDLs for the Maryland portion of the Chesapeake Bay and tidal tributaries and embayments impaired by excess nitrogen, phosphorus, and sediment as recognized in the MOU between Maryland and EPA (CBP PSC 2007).

### Chesapeake Bay Foundation Settlement Agreement

In January 2009, the Chesapeake Bay Foundation and others filed suit against EPA in U.S. District Court for the District of Columbia (1:09-cv-00005-CKK) alleging, among other things, that EPA had failed to carry out nondiscretionary duties under CWA section 117(g) designed to restore and preserve the Chesapeake Bay. In May 2010, EPA signed a settlement agreement with the plaintiffs promising to take a number of actions to restore and preserve the Bay. In particular, EPA promised that by December 31, 2010, it would establish a TMDL for those segments of the Chesapeake Bay impaired by nitrogen, phosphorus, and sediment. EPA is establishing this TMDL, in part, to meet that commitment.

# SECTION 2. WATERSHED AND IMPAIRMENT DESCRIPTION

This section provides a general description of the watershed and the impairments addressed in the Chesapeake Bay TMDL. Section 2.1 provides a description of the basic history, geography, land uses, and recent development patterns and trends. Section 2.2 presents the scope of the Bay TMDL including the parameters of concern, the specific impairment listings addressed, and the Bay TMDL segmentation.

## 2.1 GENERAL WATERSHED SETTING

The Chesapeake Bay watershed includes parts of six states—Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia—and the entire District of Columbia (collectively, the jurisdictions). The Chesapeake Bay proper is approximately 200 miles long, stretching from Havre de Grace, Maryland, to Norfolk, Virginia. It varies in width from about 3.4 miles near Aberdeen, Maryland, to 35 miles near the mouth of the Potomac River. The easternmost boundary of the Chesapeake Bay with the Atlantic Ocean is represented by a line between Cape Charles and Cape Henry. Including its tidal tributaries and embayments, the Chesapeake Bay encompasses approximately 11,684 miles of shoreline, a length longer than the entire West Coast of the United States.

About half of the Bay's water volume consists of saltwater from the Atlantic Ocean. The other half is freshwater that drains into the Bay from its 64,000-square-mile watershed (Figure 2-1). Ninety percent of the freshwater is delivered from five major rivers: the Susquehanna (which is responsible for about 50 percent), Potomac, James, Rappahannock, and York rivers. In all, the watershed contains more than 10,000 streams and rivers that eventually flow into the Bay.

Runoff from the Bay's enormous watershed flows into an estuary with a surface area of 4,500 square miles resulting in a land-to-water ratio of 14 to 1. That large ratio is one of the key factors in explaining why the drainage area has such a significant influence on water quality in the Bay.

Although the Chesapeake Bay is entirely within the Atlantic Coastal Plain, its watershed includes parts of the Piedmont and Appalachian provinces. The waters that flow into the Bay have different chemical characteristics, depending on the geology from which they originate (Figure 2-2).

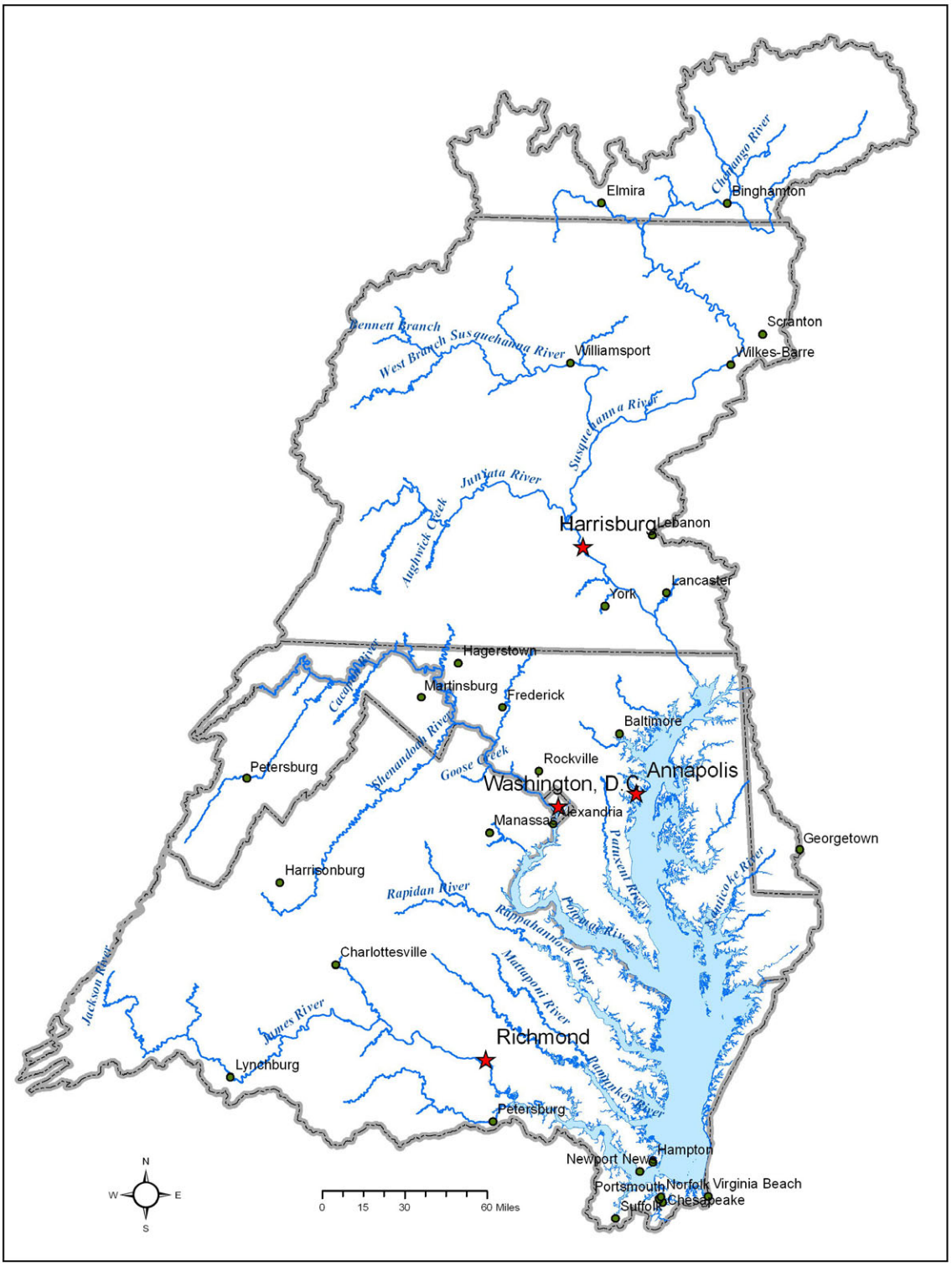
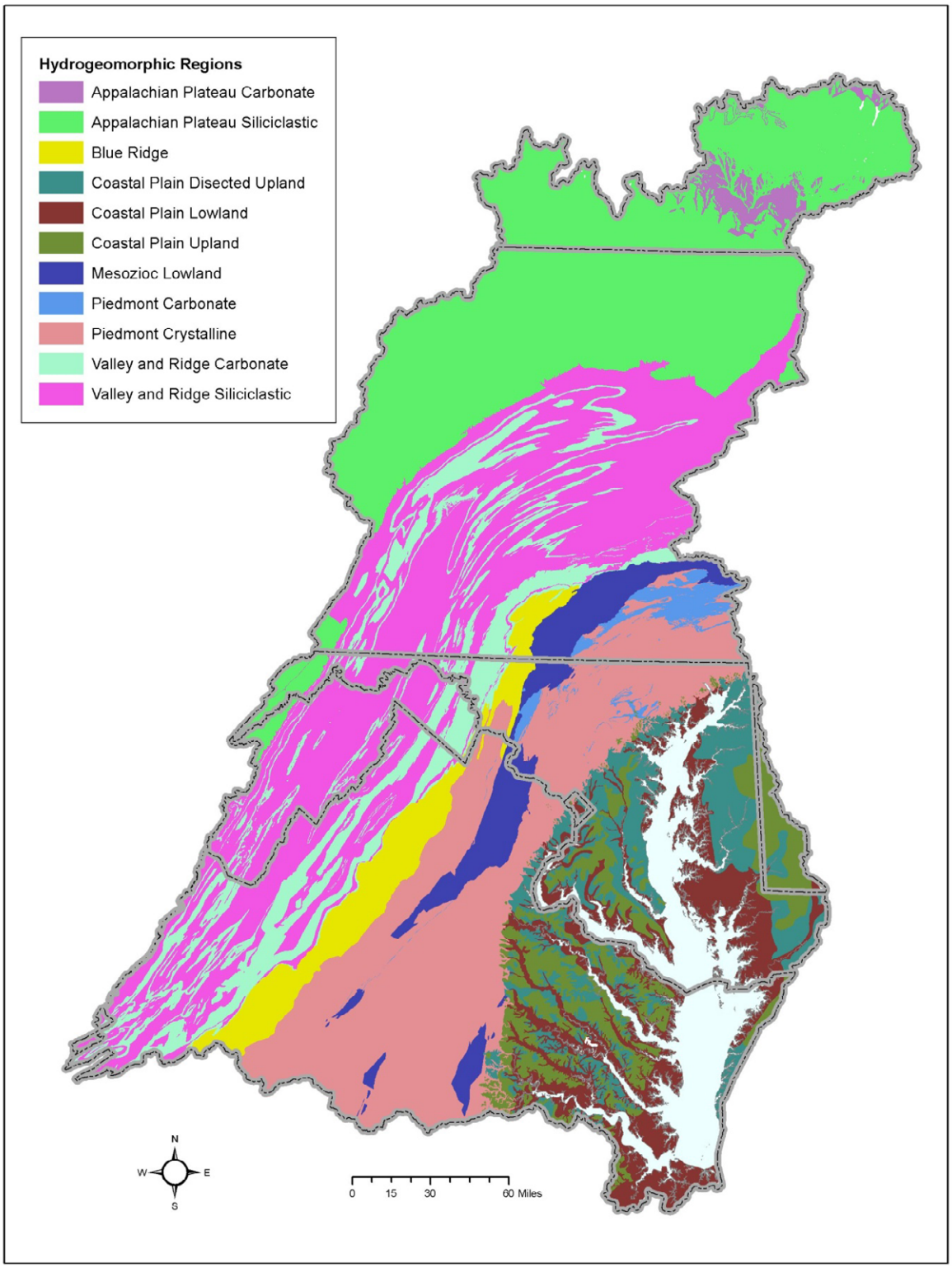



**Figure 2-1. The Chesapeake Bay watershed with major rivers and cities.**




Source: USGS WRIR 00-424

**Figure 2-2. Hydrogeomorphic regions of the Chesapeake Bay watershed.**

The Atlantic Coastal Plain is a flat, lowland area with a maximum elevation of about 300 feet. It is supported by a bed of crystalline rock, covered with southeasterly dipping wedge-shaped layers of relatively unconsolidated sand, clay, and gravel. Water passing through the loosely compacted mixture dissolves many of the minerals. The most soluble elements are iron, calcium, and magnesium. The coastal plain extends from the edge of the continental shelf, to the east, to a fall line that ranges from 15 to 90 miles west of the Chesapeake Bay. The fall line, which is the location where free flowing streams enter tidal waters, forms the boundary between the Piedmont Plateau and the coastal plain. Waterfalls and rapids clearly mark this line, which is close to Interstate 95. At the fall line, the elevation rises to 1,100 feet.

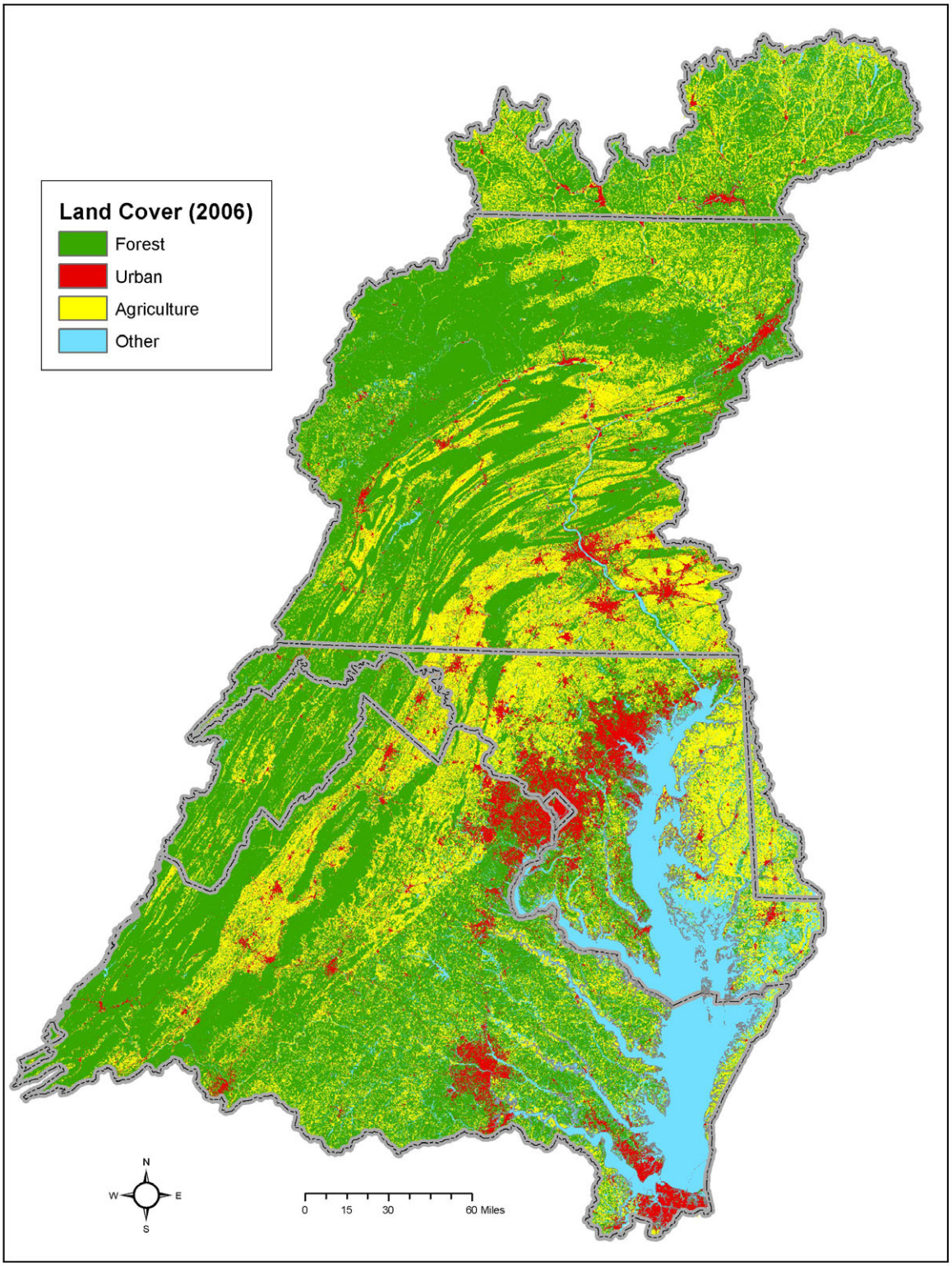
The Piedmont Plateau extends from the fall line in the east to the Appalachian Mountains in the west. The area is divided into two geologically distinct regions by Parrs Ridge, which traverses Carroll, Howard, and Montgomery counties in Maryland and adjacent counties in Pennsylvania. Several types of dense, crystalline rock—including slates, schists, marble, and granite—compose the eastern side of the Piedmont Plateau. That variety results in a very diverse topography. Rocks of the Piedmont tend to be impermeable, and water from the eastern side is low in calcium and magnesium salts. The western side of the Piedmont consists of sandstones, shales, and siltstones, layered over by limestone. The limestone bedrock contributes calcium and magnesium to its water, making it hard. Waters from the western side of Parrs Ridge flow into the Potomac River, one of the Chesapeake Bay's largest tributaries.

The Appalachian Province covers the western and northern part of the watershed and is rich in coal and natural gas deposits. Sandstone, siltstone, shale, and limestone form the bedrock. Water from that province flows to the Chesapeake Bay mainly via the Susquehanna River.

Earliest evidence of human inhabitants in the Bay watershed is of hunter-gatherers as long as 10,000 years ago. Native Americans began cultivating crops and settling in villages throughout the area around 1,000 years ago. European settlement less than 500 hundred years ago began a period of transformation of forests into farmland, while today many of those lands are undergoing retransformations into urban and suburban lands.

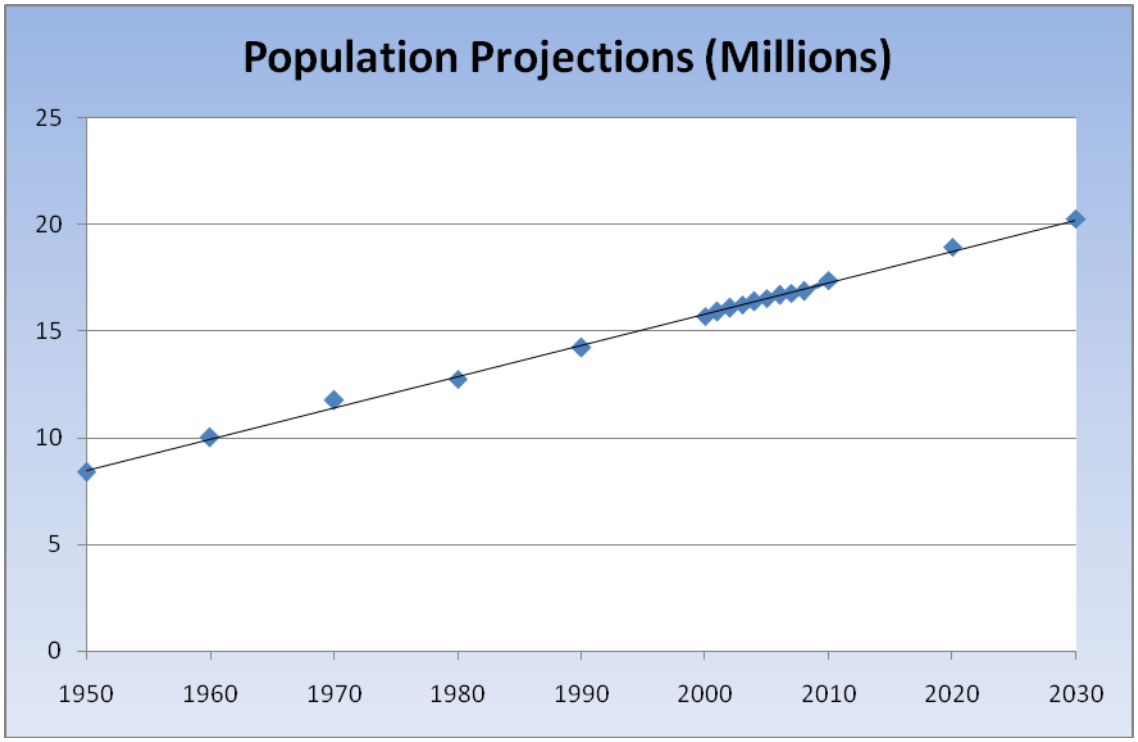
Over the past hundreds of years, forest clearing and urban development have resulted in the following land use breakdown in the watershed: 69 percent wooded/open, 22 percent agriculture, 7 percent developed, and 2 percent open water and extractive (Figure 2-3).

From 1950 through 2008, the Bay watershed's population doubled, increasing from 8.3 million to 16.8 million. The 8-year period from 2000 to 2008 witnessed population growth of approximately 7 percent from 15.7 million. Today, nearly 17 million people live in the watershed. According to census data, the watershed's population is growing by about 157,000 per year. Projections through 2030 are for the population to reach approximately 20 million (Figure 2-4).




Source: Irani and Claggett 2010

**Figure 2-3. Chesapeake Bay watershed land cover.**




Source: CBP Office Bay Barometer 2009

**Figure 2-4. Reported and projected human population growth in the Chesapeake Bay watershed 1950–2030.**

## 2.2 CHESAPEAKE BAY TMDL SCOPE

The Chesapeake Bay TMDL is the largest, most complex TMDL in the country, covering a 64,000-square-mile area across seven jurisdictions. EPA established a federal TMDL for the tidal segments of the Chesapeake Bay and its tidal tributaries and embayments that are impaired for aquatic life uses due to excessive loads of nutrients (nitrogen and phosphorus) and sediment and listed on the four tidal Bay jurisdictions' respective CWA 2008 section 303(d) lists of impaired waters. The Bay TMDL also allocates loadings of nitrogen, phosphorus, and sediment to sources contributing those pollutants in all seven jurisdictions in the Bay watershed—Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

As described more fully in Section 2.2.1 below, the Chesapeake Bay TMDL addresses only the restoration of aquatic life uses for the Bay and its tidal tributaries and embayments that are impaired from excess nitrogen, phosphorus, and sediment pollution. If Bay segments are impaired for other pollutants, EPA expects that the Bay watershed jurisdictions will develop separate TMDLs to address those pollutants.

Thousands of previously approved TMDLs have been established to protect local waters across the Chesapeake Bay watershed. While many addressed other pollutants, some addressed nitrogen, phosphorus, and/or sediment. For watersheds and waterbodies where both local TMDLs and Chesapeake Bay TMDLs have already been developed or established for nitrogen, phosphorus, and sediment, the more stringent of the TMDLs will apply. In some cases, the reductions required to meet local conditions shown in existing TMDLs may be more stringent than those needed to meet Bay requirements, and vice versa.

### 2.2.1 Pollutants of Concern

The pollutants of concern for this TMDL are nutrients—nitrogen and phosphorus—and sediment. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low DO, and reduced water clarity (Smith et al. 1992; Kemp et al. 2005). The effect of nitrogen and phosphorus loads on water quality and living resources can vary considerably by season and region.

Sediment suspended in the water column reduces the amount of light available to support healthy and extensive SAV or underwater Bay grass communities (Dennison et al. 1993; Kemp et al. 2004). The relative contribution of suspended sediment and algae that causes poor light conditions varies with location in the Bay tidal waters (Gallegos 2001).

Sediment also can contain other pollutants. For example, certain bacteria (e.g., *Escherichia coli*) often cling to sediment. By reducing sediment, reductions in phosphorus delivered to the Bay (and possibly other pollutants such as *E. coli*) also will occur. However, EPA is not providing allocations for *E. coli* or other additional pollutants in this TMDL.

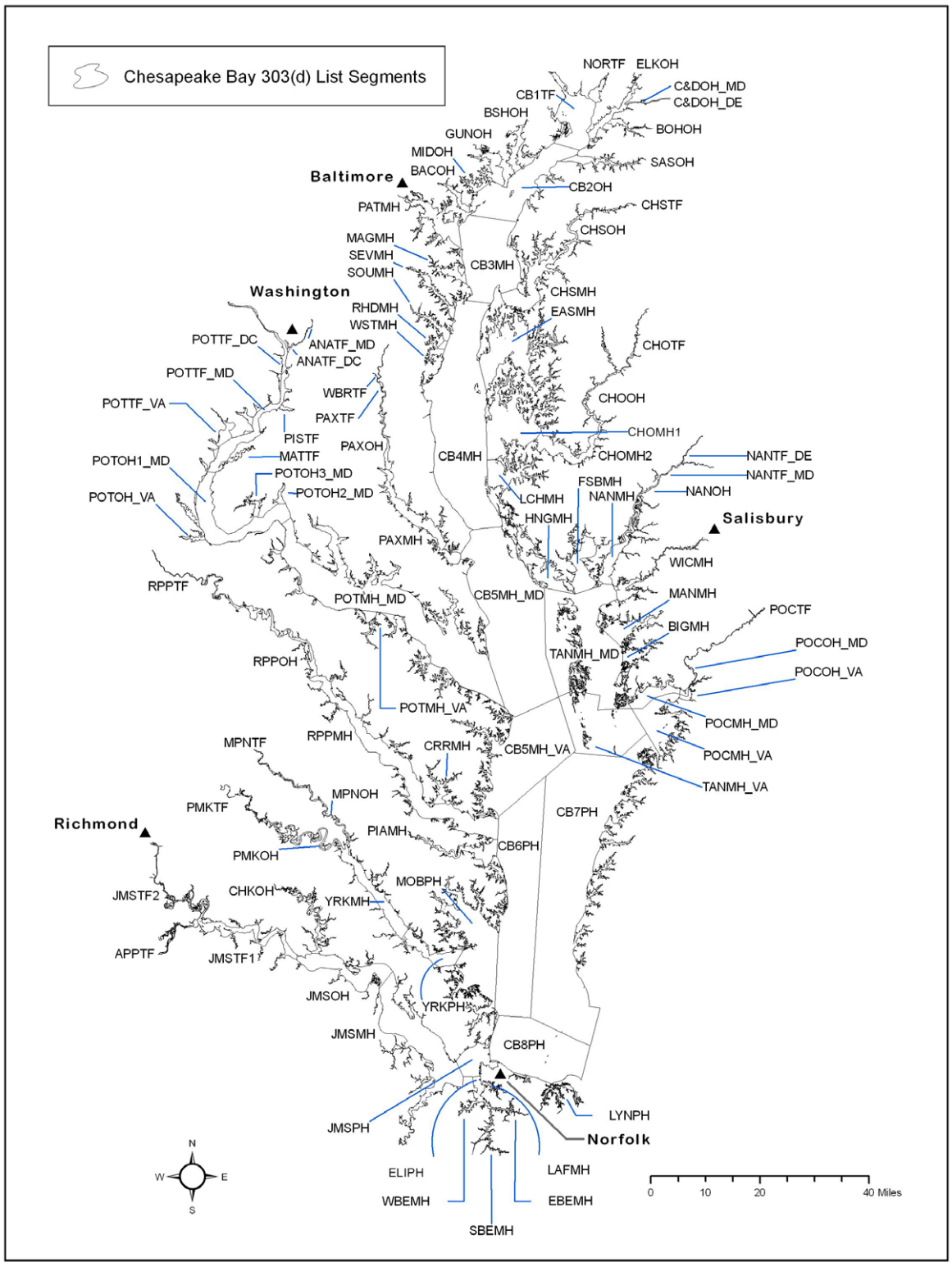
If Bay segments are impaired for other pollutants, EPA expects that the Bay watershed jurisdictions will develop separate TMDLs to address those pollutants. Because of the actions taken to achieve the Chesapeake Bay TMDL, direct benefits to local water quality conditions in surface waters throughout the Chesapeake Bay watershed also will occur.

### 2.2.2 Chesapeake Bay Program Segmentation Scheme

For 27 years, the CBP partners have used various versions of a basic segmentation scheme to organize the collection, analysis, and presentation of environmental data relating to the Chesapeake Bay. The *Chesapeake Bay Program Segmentation Scheme: Revisions, Decisions and Rationales* provides documentation of the spatial segmentation scheme of the Chesapeake Bay and its tidal tributaries and the later revisions and changes over almost thirty years (USEPA 1983b, 2004b, 2005, 2008a).

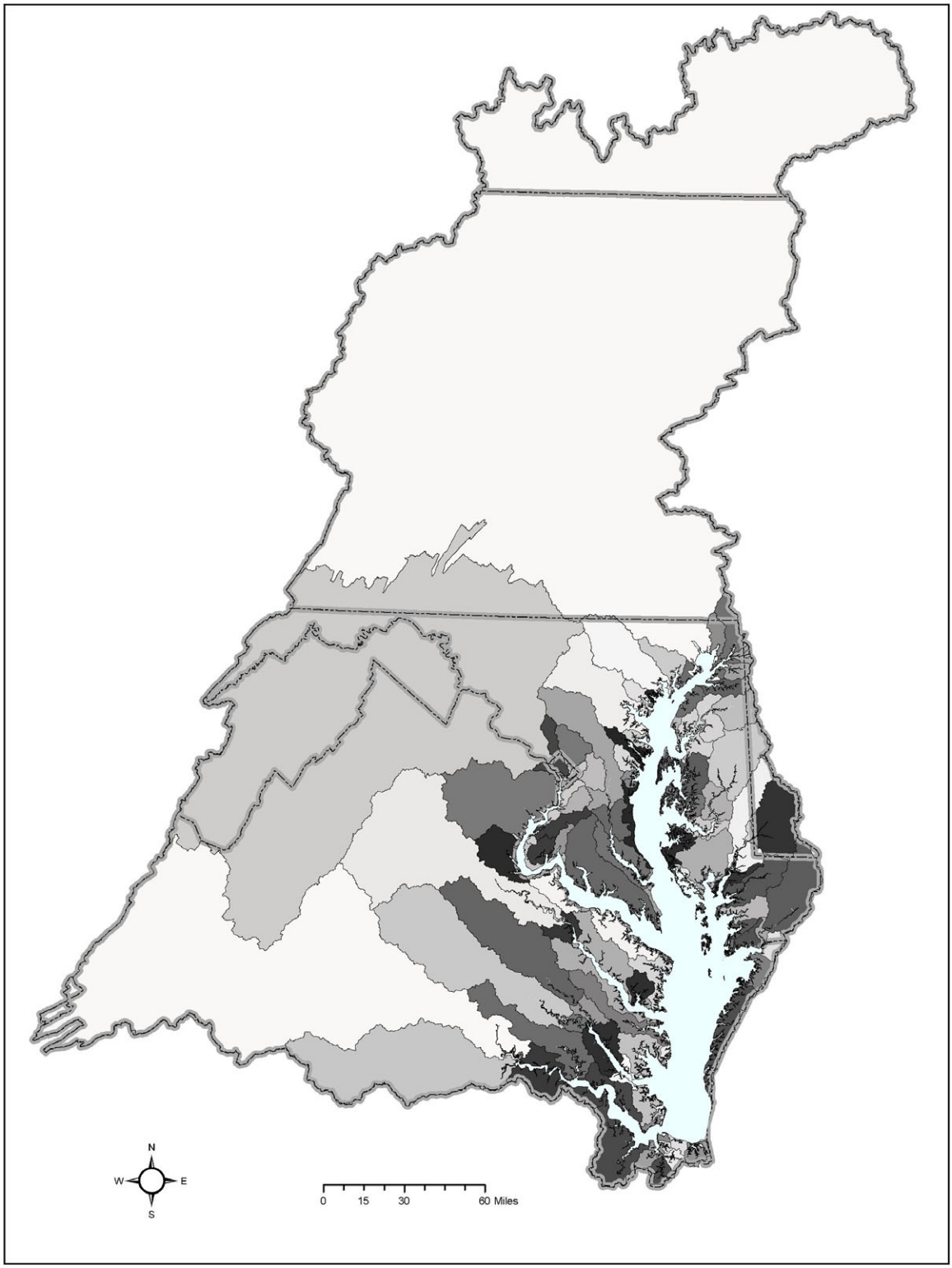
Segmentation is the compartmentalization of the estuary into subunits on the basis of selection criteria (USEPA 2008a). Generally, segments reflect certain unique physical, chemical or biological characteristics of a portion of a waterbody (e.g., salinity, influence of pollutant sources, etc.). The 92-segment scheme used in the Chesapeake Bay was derived from the 2004 published 78-segment scheme with additional jurisdictional boundary lines imposed to create 89 segments (USEPA 2004b, 2008a). The scheme includes only the split segments[1] agreed to by the CBP partnership for the tidal James and Potomac rivers for a total of 92 segments (Figure 2-5) (Table 2-1) (USEPA 2008a). The 92 individual watersheds that drain directly into one of the 92 Chesapeake Bay segments are referred to in this document as Bay segment watersheds (Figure 2-6).

[1] A split segment refers to when an established tidal Bay segment was fully bisected for purposes of applying different water quality criteria specific to two different portions of the same segment—in the case of the James River, or different assessments of attainment of the same applicable criteria separately from the main river segment—in the case of the Potomac River.




Source: USEPA 2008a

**Figure 2-5. The 92 Chesapeake Bay segments.**




Source: USEPA 2008a

**Figure 2-6. The 92 Chesapeake Bay segment watersheds.**

Table 2-1 lists the eight major river basins draining to the Chesapeake Bay and their associated Bay segments with information related to each Bay segment's 2008 section 303(d) list status and whether the Bay segment is addressed by a consent decree or MOU. The 303(d) Integrated Report listing categories are as follows:

- Category 1—attaining all WQS
- Category 2—attaining some WQS
- Category 3—insufficient information to determine if WQS are attained
- Category 4—impaired or threatened waters that do not need or already have completed a TMDL
  - 4a—TMDL has been completed
  - 4b—Other pollution control requirements are reasonably expected to result in the attainment of the WQS in the near future
  - 4c—Impairment is not caused by a pollutant
- Category 5—impaired or threatened water that requires a TMDL

Most Bay segments are listed as category 5 (impaired for most/all designated uses); exceptions are noted in Table 2-1.

**Table 2-1. The Chesapeake Bay 303(d) tidal segments with consent decree (CD)/ memorandum of understanding (MOU) and 303(d) listing status by major river basin and jurisdiction**

| Major river basin | Jurisdiction | Chesapeake Bay 303(d) segment | Segment ID | CD/MOU | 2008 list status[a] |
|---|---|---|---|---|---|
| Eastern Shore | MD | Big Annemessex River | BIGMH | -- | 5 |
| | MD | Bohemia River | BOHOH | MD MOU | 4a for TN and TP |
| | DE | C&D Canal, DE | C&DOH_DE | -- | 5 |
| | MD | C&D Canal, MD | C&DOH_MD | MD MOU | 5 |
| | MD | Eastern Bay | EASMH | MD MOU | 5 |
| | VA | Eastern Lower Chesapeake Bay | CB7PH | VA CD | 5 |
| | MD | Elk River | ELKOH | MD MOU | 5 |
| | MD | Fishing Bay | FSBMH | MD MOU | 4a for TN and TP |
| | MD | Honga River | HNGMH | MD MOU | 5 |
| | MD | Little Choptank River | LCHMH | MD MOU | 5 |
| | MD | Lower Chester River | CHSMH | MD MOU | 5 |
| | MD | Lower Choptank River | CHOMH2 | MD MOU | 5 |
| | MD | Lower Nanticoke River | NANMH | -- | 5 |
| | MD | Lower Pocomoke River, MD | POCMH_MD | MD MOU | 5 |
| | VA | Lower Pocomoke River, VA | POCMH_VA | VA CD | 5 |
| | MD | Manokin River | MANMH | MD MOU | 4a for TN and TP |
| | MD | Middle Chester River | CHSOH | MD MOU | 4a for TN and TP |

| Major river basin | Jurisdiction | Chesapeake Bay 303(d) segment | Segment ID | CD/MOU | 2008 list status[a] |
|---|---|---|---|---|---|
| | MD | Middle Choptank River | CHOOH | MD MOU | 5 |
| | MD | Middle Nanticoke River | NANOH | MD MOU | 5 |
| | MD | Middle Pocomoke River, MD | POCOH_MD | MD MOU | 5 |
| | VA | Middle Pocomoke River, VA | POCOH_VA | -- | 5 |
| | MD | Mouth of Choptank River | CHOMH1 | MD MOU | 5 |
| | MD | Northeast River | NORTF | MD MOU | 4a for TN and TP |
| | MD | Sassafras River | SASOH | MD MOU | 4a for TP |
| | MD | Tangier Sound, MD | TANMH_MD | MD MOU | 5 |
| | VA | Tangier Sound, VA | TANMH_VA | -- | 5 |
| | MD | Upper Chester River | CHSTF | MD MOU | 4a for TN and TP |
| | MD | Upper Choptank River | CHOTF | MD MOU | 5 |
| | DE | Upper Nanticoke River, DE | NANTF_DE | DE CD finished | 5 |
| | MD | Upper Nanticoke River, MD | NANTF_MD | MD MOU | 5 |
| | MD | Upper Pocomoke River | POCTF | MD MOU | 5 |
| | MD | Wicomico River | WICMH | MD MOU | 5 |
| James | VA | Appomattox River | APPTF | -- | 5 |
| | VA | Chickahominy River | CHKOH | -- | 5 |
| | VA | Eastern Branch Elizabeth River | EBEMH | VA CD | 5 |
| | VA | Lafayette River | LAFMH | -- | 5 |
| | VA | Lower James River | JMSMH | VA CD | 5 |
| | VA | Lynnhaven River | LYNPH | VA CD | 5 |
| | VA | Middle James River | JMSOH | VA CD | 5 |
| | VA | Mouth of Chesapeake Bay | CB8PH | -- | 5 |
| | VA | Mouth of James River | JMSPH | VA CD | 5 |
| | VA | Mouth to mid-Elizabeth River | ELIPH | VA CD | 5 |
| | VA | Southern Branch Elizabeth River | SBEMH | VA CD | 5 |
| | VA | Upper James River - Lower | JMSTF1 | VA CD | 5 |
| | VA | Upper James River - Upper | JMSTF2 | VA CD | 5 |
| | VA | Western Branch Elizabeth River | WBEMH | VA CD | 5 |
| Patuxent | MD | Lower Patuxent River | PAXMH | MD MOU | 5 |
| | MD | Middle Patuxent River | PAXOH | MD MOU | 5 |
| | MD | Upper Patuxent River | PAXTF | MD MOU | 5 |

| Major river basin | Jurisdiction | Chesapeake Bay 303(d) segment | Segment ID | CD/MOU | 2008 list status[a] |
|---|---|---|---|---|---|
| | MD | Western Branch Patuxent River | WBRTF | MD MOU | BOD TMDL completed for DO impairments; 4a for BOD |
| Potomac | DC | Anacostia River, DC | ANATF_DC | DC CD | 3 for DO; 4a for BOD, TN, TP and TSS |
| | MD | Anacostia River, MD | ANATF_MD | MD MOU | 4a for BOD, TN, TP and TSS |
| | VA | Lower Central Chesapeake Bay, VA [b] | CB5MH_VA [b] | VA CD | 5 |
| | MD | Lower Potomac River, MD | POTMH_MD | MD MOU | 5 |
| | VA | Lower Potomac River, VA | POTMH_VA | VA CD | 5 |
| | MD | Mattawoman Creek | MATTF | MD MOU | 5 |
| | MD | Middle Potomac River, MD - Mainstem | POTOH1_MD | MD MOU | 5 |
| | MD | Middle Potomac River, MD - Nanjemoy Creek | POTOH2_MD | MD MOU | 5 |
| | MD | Middle Potomac River, MD - Port Tobacco River | POTOH2_MD | MD MOU | 4a for TN and TP |
| | VA | Middle Potomac River, VA | POTOH_VA | -- | 3 for DO in Migratory Spawning and Nursery (MSN); 2 for SAV and DO in open water |
| | MD | Piscataway Creek | PISTF | MD MOU | 5 |
| | DC | Upper Potomac River, DC | POTTF_DC | DC CD | 3 for DO, 5 for pH |
| | MD | Upper Potomac River, MD | POTTF_MD | MD MOU | 5 |
| | VA | Upper Potomac River, VA | POTTF_VA | -- | 3 for DO in Migratory Spawning and Nursery; 2 for SAV and DO in open water |
| Rappa-hannock | VA | Corrotoman River | CRRMH | -- | 5 |
| | VA | Lower Rappahannock River | RPPMH | VA CD | 5 |

| Major river basin | Jurisdiction | Chesapeake Bay 303(d) segment | Segment ID | CD/MOU | 2008 list status[a] |
|---|---|---|---|---|---|
| | VA | Middle Rappahannock River | RPPOH | -- | 3 for DO in Migratory Spawning and Nursery; 2 for SAV and DO in open water |
| | VA | Upper Rappahannock River | RPPTF | -- | 5 |
| | VA | Western Lower Chesapeake Bay[b] | CB6PH[b] | VA CD | 5 |
| Susque-hanna | MD | Northern Chesapeake Bay[b] | CB1TF[b] | MD MOU | 5 |
| Western Shore | MD | Back River | BACOH | MD MOU | 4a for TN and TP |
| | MD | Bush River | BSHOH | MD MOU | 5 |
| | MD | Gunpowder River | GUNOH | MD MOU | 5 |
| | MD | Lower Central Chesapeake Bay, MD[b] | CB5MH_MD[b] | MD MOU | 5 |
| | MD | Magothy River | MAGMH | MD MOU | 5 |
| | MD | Middle Central Chesapeake Bay[b] | CB4MH[b] | MD MOU | 5 |
| | MD | Middle River | MIDOH | MD MOU | 5 |
| | MD | Patapsco River | PATMH | MD MOU | 5 |
| | MD | Rhode River | RHDMH | MD MOU | 5 |
| | MD | Severn River | SEVMH | MD MOU | 5 |
| | MD | South River | SOUMH | MD MOU | 5 |
| | MD | Upper Central Chesapeake Bay[b] | CB3MH[b] | MD MOU | 5 |
| | MD | Upper Chesapeake Bay[b] | CB2OH[b] | MD MOU | 5 |
| | MD | West River | WSTMH | MD MOU | 5 |
| York | VA | Lower Mattaponi River | MPNOH | VA CD | 5 |
| | VA | Lower Pamunkey River | PMKOH | VA CD | 5 |
| | VA | Lower York River | YRKPH | VA CD | 5 |
| | VA | Middle York River | YRKMH | VA CD | 5 |
| | VA | Mobjack Bay | MOBPH | -- | 5 |
| | VA | Piankatank River | PIAMH | -- | 5 |
| | VA | Upper Mattaponi River | MPNTF | VA CD | 5 |
| | VA | Upper Pamunkey River | PMKTF | VA CD | 5 |

Sources: American Canoe Association v. EPA; American Littoral Society, et al. v. EPA, et al.; DC DOH 1998; DC DOE 2008; DE DNREC 1996; DE DNREC 2008; Kingman Park Civic Association, et al. vs. EPA; MDE 1998, 2004, 2008; USEPA 2008 a; VA DEQ 1998; VA DEQ 2008

a. BOD = biological oxygen demand; DO = dissolved oxygen; TN = total nitrogen; TP = total phosphorus; TSS = total suspended solids

b. More than one river basin flows into this tidal segment

### 2.2.3 Jurisdictions' 2008 303(d) Listings

The Chesapeake Bay TMDL is based on the most recent EPA-approved tidal Bay jurisdictions' section 303(d) lists, which are the 2008 303(d) listings.[2] Those section 303(d) lists identify 89 of the 92 Chesapeake Bay segments as impaired on either Category 4a (impaired, TMDL has been developed) or Category 5 (impaired, needs TMDL) because of various factors, including low DO levels, insufficient SAV, excess chlorophyll *a*, biological/nutrient indicators, total nitrogen, total phosphorus, total suspended solids (TSS), biological oxygen demand (BOD), and pH (caused by excessive nitrogen and phosphorus fueling algal blooms) (DC DOE 2008; DE DNREC 2008; MDE 2008; VADEQ 2008).

Three Chesapeake Bay segments are not listed in Category 4a or 5 on Virginia's 2008 integrated report:

- Upper Potomac River (POTTF_VA)
- Middle Potomac River (POTOH_VA)
- Middle Rappahannock River (RPPOH)

Those three segments are listed as either Category 2 (some uses met, other uses have insufficient information to determine impairment) or Category 3 (insufficient information to determine if impaired) (VA DEQ 2008). Because their listing status raises a reasonable possibility that they are impaired, and because those segments are tidally interconnected with other impaired Bay segments, it is appropriate that they also be addressed by the Chesapeake Bay TMDL.

The first segment, Virginia's Upper Potomac River (POTTF_VA), encompasses a series of small tidal embayments that are tidally interconnected with Maryland's Upper Potomac River (POTTF_MD) segment and the District of Columbia's Upper Potomac River (POTTF_DC) segment (USEPA 2008a), both of which are listed as Category 5 of Maryland's and the District of Columbia's respective 2008 integrated reports (DCDOE 2008; MDE 2008). Loads originating in the watershed that drains directly to Virginia's Upper Potomac River segment influence the water quality in the two adjacent Maryland and District of Columbia impaired tidal segments and other down-tide segments.

The second segment, Virginia's Middle Potomac River (POTOH_VA), also encompasses a series of small tidal embayments that are tidally interconnected with Maryland's Middle Potomac River (POTOH_MD) segment (USEPA 2008a), which is listed as Category 5 on Maryland's 2008 integrated report (MDE 2008). Loads originating in the watershed that drains directly to Virginia's Middle Potomac River segment influence the water quality in the adjacent Maryland impaired tidal segment and other down-tide impaired segments.

The third segment, Virginia's Middle Rappahannock River (RPPOH), is tidally interconnected with both the Lower Rappahannock River (RPPMH) and the Upper Rappahannock River (RPPTF) segments (USEPA 2008a), both of which are listed as Category 5 on Virginia's 2008 integrated report (VADEQ 2008). Loads originating in the watershed that drains directly to

[2] At the time EPA applied the Bay models for development of the allocations starting in 2009, the 2008 section 303(d) lists were the most recent approved lists. Although EPA subsequently received 2010 section 303(d) lists for approval from all tidal jurisdictions, EPA used the approved 2008 lists in establishing the Bay TMDL to have a consistent basis for the TMDL.

Virginia's Middle Rappahannock River segment influence the water quality in the adjacent Virginia impaired tidal segments and other down-tide segments.

As detailed in Section 9, TMDLs have been completed as part of the Chesapeake Bay TMDL for all 92 Chesapeake Bay segments listed in Table 2-1 (see Section 9). These include TMDLs for the above described three Virginia Bay segments because they flow into impaired tidal Bay segments, and reductions in nitrogen, phosphorus, and sediment loadings from their respective watersheds, therefore, are necessary to achieve the Bay jurisdictions' Chesapeake Bay WQS.

### 2.2.4 2008 303(d) Listing Segments Compared to Consent Decree and MOU Segments

To ensure that EPA established TMDLs for all necessary Bay segments—all 2008 listed segments, all Virginia, Delaware, and the District of Columbia TMDL consent decree segments, and all Maryland MOU segments—EPA compared the 2008 listed segments with those included on those consent decrees and MOUs (Table 2-1). In total, 77 segments are addressed by the Virginia and District of Columbia consent decrees and the Maryland MOU: 22 segments are on the Virginia TMDL consent decree; 2 segments are on the Delaware TMDL consent decree; 2 segments are on the District of Columbia TMDL consent decree; and 51 segments are on the Maryland TMDL MOU (Table 2-2). The evaluation found that all segments of the Virginia consent decree, Delaware consent decree, the District of Columbia consent decree, and Maryland MOU are included in the list of 92 Chesapeake Bay segments for which nitrogen, phosphorus, and sediment TMDLs have been established under the Bay TMDL.

**Table 2-2. Comparison of consent decree/MOU segments with total number of Bay segments**

| Jurisdiction | Consent decree or MOU segments | Chesapeake Bay segments |
|---|---|---|
| Virginia | 22 | 35 |
| District of Columbia | 2 | 2 |
| Maryland | 51 | 53 |
| Delaware | 2[a] | 2 |
| Total | 77 | 92 |

Source: Adapted from Table 2-1.
a. Two consent decrees affect one Bay segment in Delaware, but TMDLs have already been established for both waterbodies.

# SECTION 3. CHESAPEAKE BAY WATER QUALITY STANDARDS

WQS consist of four basic elements: designated uses, water quality criteria, an antidegradation policy (to maintain and protect existing uses and high-quality waters), and general policies (addressing implementation issues such as low flows, variances, and mixing zones). Designated uses are a jurisdiction's goals and expectations for each of the individual surface waters (e.g., coldwater fisheries, public water supply, and primary contact recreation). EPA's WQS regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR 131.3). Water quality criteria may be numeric or narrative, and represent a quality of water that supports a particular use. When water quality criteria are met, water quality is expected to protect its designated use. Numeric water quality criteria are generally chemical-specific and reflect specific levels of pollutants that, if found in the waterbody, do not impair its designated uses (e.g., physical or chemical characteristics like temperature, minimum concentration of DO, and the maximum concentrations of toxic pollutants).

Starting in 1986, EPA and its CBP partners embarked on a process to synthesize scientific evidence on the water quality requirements of hundreds of aquatic species and biological communities inhabiting Chesapeake Bay and its tidal tributaries and embayments. The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). The CBP partnership initially published two syntheses of the available scientific findings supporting establishment of habitat requirements for 31 target species (CBP 1987; Funderburk et al. 1991). Those efforts spawned development and publication of synthesis documents focused on DO requirements (Jordan et al. 1992) and underwater Bay grasses habitat requirements (Batiuk et al. 1992, 2000). On the basis of that work, in part, EPA published as guidance the Chesapeake Bay water quality criteria (USEPA 2003a) and the Chesapeake Bay refined aquatic life designated uses and attainability (USEPA 2003d) documents.

Guided by those efforts, Delaware, the District of Columbia, Maryland, and Virginia adopted jurisdiction-specific Chesapeake Bay WQS regulations in 2004–2005 consistent with the EPA published guidance. EPA then reviewed and approved the four tidal Bay jurisdictions' WQS submissions pursuant to CWA section 303(c).

Since 2005, Delaware, Maryland, Virginia, and the District of Columbia each has proposed and adopted very specific amendments to its respective Chesapeake Bay WQS regulations. Each jurisdiction's process for amending its existing Chesapeake Bay WQS regulations requires full public notice, public review and comment, and response to public comments before submission to EPA Region 3 for final EPA review and approval.

## 3.1 CHESAPEAKE BAY WATER QUALITY CRITERIA AND DESIGNATED USES

The above described DO, underwater Bay grasses, and Bay habitat requirements documents (Batiuk et al. 1992, 2000; CBP 1987; Funderburk et al. 1991; Jordan et al. 1991), supplemented by additional scientific research findings, provided the basis for developing the applicable water quality criteria guidance for the Chesapeake Bay. The criteria assessment guidance is documented within EPA's Bay criteria (USEPA 2003a), designated uses/attainability (USEPA 2003d), and Bay segmentation (USEPA 2004b) documents and the subsequent seven addenda (USEPA 2004a, 2004e, 2005, 2007a, 2007b, 2008a, 2010a). EPA Region 3 published those documents as guidance in accordance with CWA sections 117(b) and 303 to derive water quality criteria specifically for addressing the critical nutrient and sediment enrichment parameters necessary to protect designated aquatic life uses in the Bay (Table 3-1). These criteria serve as surrogate numeric criteria for nitrogen, phosphorus, and sediment.

**Table 3-1. Chesapeake Bay water quality criteria and designated use related documentation and addenda**

| Document title | Month/year published | Document content and description |
|---|---|---|
| *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries.* EPA 903-R-03-002. [USEPA 2003a] | April 2003 | Original Chesapeake Bay water quality criteria document. |
| *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability.* EPA 903-R-03-004. [USEPA 2003d] | October 2003 | Original Chesapeake Bay tidal waters designated uses document. |
| *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries—2004 Addendum.* EPA 903-R-03-002. [USEPA 2004a] | October 2004 | Addresses endangered species protection, assessment of DO criteria, derivation of site-specific DO criteria, pycnocline boundary delineation methodology, and updated water clarity criteria/SAV restoration acreage assessment procedures. |
| *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability—2004 Addendum.* EPA 903-R-04-006. [USEPA 2004e] | October 2004 | Addresses refinements to Bay tidal waters designated use boundaries, segmentation boundaries, and Potomac River jurisdictional boundaries; documents SAV no-grow zones, restoration goal, and shallow-water acreages. |
| *Chesapeake Bay Program Analytical Segmentation Scheme: Revisions, Decisions and Rationales 1983–2003.* EPA 903-R-04-008. CBP/TRS 268-04. [USEPA 2004b] | October 2004 | Details documentation on the history of the segmentation schemes and provides coordinates, georeferences, and narrative descriptions of the 2003 segmentation scheme. |

| Document title | Month/year published | Document content and description |
|---|---|---|
| *Chesapeake Bay Program Analytical Segmentation Scheme: Revisions, Decisions and Rationales 1983–2003: 2005 Addendum.* EPA 903-R-05-004. CBP/TRS 278-06. [USEPA 2005] | December 2005 | Addresses methods used to subdivide the segments by jurisdiction and provides coordinates, georeferences, and narrative descriptions for those subdivided segments. |
| *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries—2007 Addendum.* EPA 903-R-07-003. CBP/TRS 285-07. [USEPA 2007a] | July 2007 | Addresses refinements to the Bay water quality DO, water clarity/SAV, and chlorophyll a criteria assessment methodologies and documents the framework for Bay tidal waters 303(d) list decision making. |
| *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries—2007 Chlorophyll Criteria Addendum.* EPA 903-R-07-005. CBP/TRS 288/07. [USEPA 2007b] | November 2007 | Publishes a set of numerical chlorophyll a criteria for Chesapeake Bay and the supporting criteria assessment procedures. |
| *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries—2008 Technical Support for Criteria Assessment Protocols Addendum.* EPA 903-R-08-001. CBP/TRS 290-08. [USEPA 2008a] | September 2008 | Addresses refinements to the Bay water quality DO, water clarity/SAV and chlorophyll a criteria assessment methodologies and documents the 2008 92-segment scheme for Bay tidal waters. |
| *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries—2010 Technical Support for Criteria Assessment Protocols Addendum.* EPA 903-R-10-002. CBP/TRS 301-10. [USEPA 2010a] | May 2010 | Addresses refinements to procedures for defining designated uses, procedures for deriving biologically based reference curves for DO criteria assessment and chlorophyll a criteria assessment procedures. |

Before adoption into each Bay jurisdiction's WQS regulations, each set of criteria, criteria assessment procedures, designated uses, and proposed WQS were subject to extensive scientific, programmatic, and public review.

The original 2003 water quality criteria, assessment procedures, and designated uses all went through independent scientific peer reviews sponsored by the CBP's STAC and public review. The CBP's Water Quality Steering Committee's water quality criteria and designated use teams then reviewed and approved them. Finally, the CBP's Water Quality Steering Committee reviewed and approved them for EPA publication on behalf of the partnership.

Since the publication of the original Chesapeake Bay water quality criteria document (USEPA 2003a), Chesapeake Bay designated uses and attainability document (USEPA 2003d), and Chesapeake Bay segmentation document (USEPA 2004b), EPA has published enhancements to the criteria assessment procedures, designated use boundaries, and Bay segmentation scheme. Specifically, EPA has published five addenda—USEPA 2004a, 2007a, 2007b, 2008a, 2010a—to the original 2003 Bay criteria document (USEPA 2003a), one addendum—USEPA 2004e—to

the original 2003 Bay designated use/attainability document (USEPA 2003d), and one addendum—USEPA 2005—to the original Bay segmentation document (USEPA 2004b) (see Table 3-1).

Those revisions have undergone independent scientific peer reviews, sponsored by the CBP's STAC, before review and approval by the CBP's Criteria Assessment Protocols Workgroup and then the Water Quality Steering Committee/Water Quality Implementation Team for EPA publication on behalf of the partnership. Examples include the cumulative frequency distribution approach (STAC 2006) and the biological reference curves (STAC 2009).

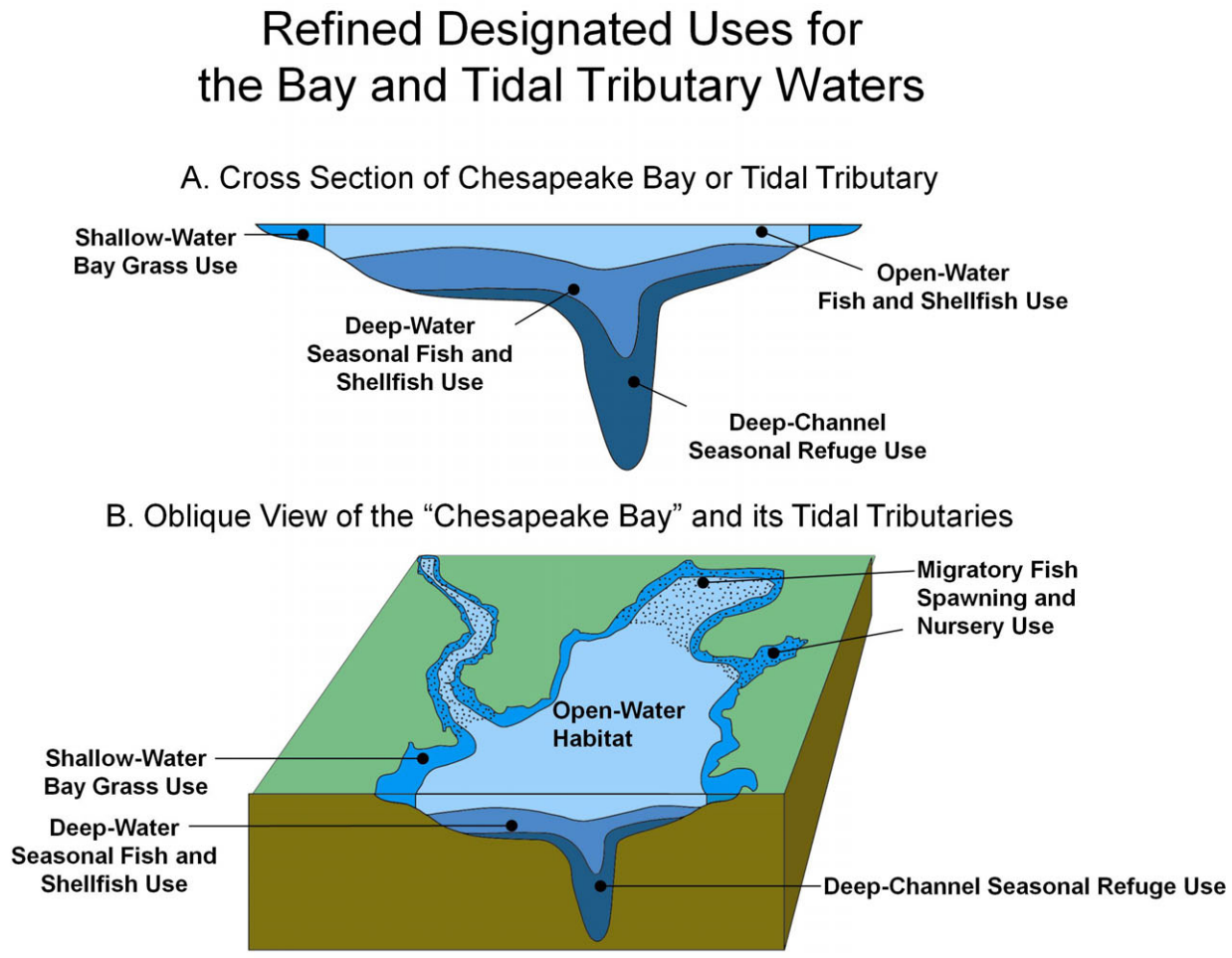
### 3.1.1 Tidal Water Designated Uses

EPA and its seven watershed jurisdiction partners agreed on five refined aquatic life designated uses reflecting the habitats of an array of recreationally, commercially, and ecologically important species and biological communities (USEPA 2003d, 2004e, 2010a). The five tidal Bay designated uses are applied, where appropriate, consistently across Delaware, the District of Columbia, Maryland, and Virginia's portions of the Chesapeake Bay and its tidal tributary and embayment waters. The vertical and horizontal breadth and temporal application of the designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, bathymetry, and other scientific considerations (USEPA 2003d, 2004e, 2010a). Table 3-2 outlines the Chesapeake Bay tidal water designated uses, which are illustrated in Figure 3-1.

**Table 3-2. Five Chesapeake Bay tidal waters designated uses**

| Tidal water designated use | Chesapeake Bay habitats and communities protected |
|---|---|
| Migratory fish spawning and nursery | Migratory and resident tidal freshwater finfish during the late winter/spring spawning and nursery season in tidal freshwater to low-salinity habitats. |
| Shallow-water Bay grass | Underwater Bay grasses and fish and crab species that depend on the shallow-water habitat provided by underwater Bay grass beds. |
| Open-water fish and shellfish | Diverse populations of sport fish, including striped bass, bluefish, mackerel and sea trout, as well as important bait fish such as menhaden and silversides in surface water habitats within tidal creeks, rivers, embayments, and the mainstem Chesapeake Bay year-round. |
| Deep-water seasonal fish and shellfish | Animals inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months (e.g., bottom-feeding fish, crabs and oysters, as well as other important species, including the Bay anchovy). |
| Deep-channel seasonal refuge | Bottom-sediment-dwelling worms and small clams that serve as food for bottom-feeding fish and crabs in the very deep channels in summer. |

Sources: USEPA 2003d, 2004e




Source: USEPA 2003d

**Figure 3-1. Conceptual illustration of the five Chesapeake Bay tidal water designated use zones.**

Table 3-3 lists the designated uses for each of the 92 Chesapeake Bay segments pursuant to Delaware, the District of Columbia, Maryland, and Virginia's existing WQS regulations. Amended based on USEPA 2010a, Table 3-3 was originally published as Table V-1 on pages 51–53 of the *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries 2007 Addendum* (USEPA 2007a), which is an updated version of Table IV-3 originally published on pages 62–63 of the 2003 *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability* (USEPA 2003d). The absence of an X in the shallow-water Bay grass designated use column indicates that the Bay segment has been entirely delineated as an SAV no-grow zone and, therefore, the shallow-water Bay grass designated use does not apply to that Bay segment (USEPA 2004e).

**Table 3-3. Current tidal water designated uses by Chesapeake Bay segment**

| CB segment name | CB segment | Juris. | Migratory fish spawning & nursery<br>Feb. 1–May 31 | Open water fish & shellfish<br>Year-round | Deep water seasonal fish & shellfish<br>June 1–Sept. 30 | Deep channel seasonal refuge<br>June 1–Sept. 30 | Shallow water Bay grasses<br>SAV growing season |
|---|---|---|---|---|---|---|---|
| Northern Chesapeake Bay | CB1TF | MD | X | X | | | X |
| Upper Chesapeake Bay | CB2OH | MD | X | X | | | X |
| Upper Central Chesapeake Bay | CB3MH | MD | X | X | X | X | X |
| Middle Central Chesapeake Bay | CB4MH | MD | X | X | X | X | X |
| Lower Central Chesapeake Bay , MD | CB5MH_MD | MD | | X | X | X | X |
| Lower Central Chesapeake Bay, VA | CB5MH_VA | VA | | X | X | X | X |
| Western Lower Chesapeake Bay | CB6PH | VA | | X | X | | X |
| Eastern Lower Chesapeake Bay | CB7PH | VA | | X | X | | X |
| Mouth of the Chesapeake Bay | CB8PH | VA | | X | | | X |
| Bush River | BSHOH | MD | X | X | | | X |
| Gunpowder River | GUNOH | MD | X | X | | | X |
| Middle River | MIDOH | MD | X | X | | | X |
| Back River | BACOH | MD | X | X | | | X |
| Patapsco River | PATMH | MD | X | X | X | | X |
| Magothy River | MAGMH | MD | X | X | X | | X |
| Severn River | SEVMH | MD | X | X | X | | X |
| South River | SOUMH | MD | X | X | X | | X |
| Rhode River | RHDMH | MD | X | X | | | X |
| West River | WSTMH | MD | X | X | | | X |
| Upper Patuxent River | PAXTF | MD | X | X | | | X |
| Western Branch Patuxent River | WBRTF | MD | X | X | | | X |
| Middle Patuxent River | PAXOH | MD | X | X | | | X |
| Lower Patuxent River | PAXMH | MD | X | X | X | | X |
| Upper Potomac River, DC | POTTF_DC | DC | X | X | | | X |
| Upper Potomac River, MD | POTTF_MD | MD | X | X | | | X |
| Upper Potomac River, VA | POTTF_VA | VA | X | X | | | X |
| Anacostia River, DC | ANATF_DC | DC | X | X | | | X |
| Anacostia River, MD | ANATF_MD | MD | X | X | | | X |
| Piscataway Creek | PISTF | MD | X | X | | | X |
| Mattawoman Creek | MATTF | MD | X | X | | | X |

| CB segment name | CB segment | Juris. | Migratory fish spawning & nursery<br>Feb. 1–May 31 | Open water fish & shellfish<br>Year-round | Deep water seasonal fish & shellfish<br>June 1–Sept. 30 | Deep channel seasonal refuge<br>June 1–Sept. 30 | Shallow water Bay grasses<br>SAV growing season |
|---|---|---|---|---|---|---|---|
| Middle Potomac River, MD-Mainstem | POTOH1_MD | MD | X | X | | | X |
| Middle Potomac River, MD-Nanjemoy Creek | POTOH2_MD | MD | X | X | | | X |
| Middle Potomac River, MD-Port Tobacco River | POTOH3_MD | MD | X | X | | | X |
| Middle Potomac River, VA | POTOH_VA | VA | X | X | | | X |
| Lower Potomac River, MD | POTMH_MD | MD | X | X | X | X | X |
| Lower Potomac River, VA | POTMH_VA | VA | X | X | X | X | X |
| Upper Rappahannock River | RPPTF | VA | X | X | | | X |
| Middle Rappahannock River | RPPOH | VA | X | X | | | X |
| Lower Rappahannock River | RPPMH | VA | X | X | X | X | X |
| Corrotoman River | CRRMH | VA | X | X | | | X |
| Piankatank River | PIAMH | VA | | X | | | X |
| Upper Mattaponi River | MPNTF | VA | X | X | | | X |
| Lower Mattaponi River | MPNOH | VA | X | X | | | |
| Upper Pamunkey River | PMKTF | VA | X | X | | | X |
| Lower Pamunkey River | PMKOH | VA | X | X | | | |
| Middle York River | YRKMH | VA | X | X | | | X |
| Lower York River | YRKPH | VA | | X | X | | X |
| Mobjack Bay | MOBPH | VA | | X | | | X |
| Upper James River-Lower | JMSTF1 | VA | X | X | | | X |
| Upper James River-Upper | JMSTF2 | VA | X | X | | | X |
| Appomattox River | APPTF | VA | X | X | | | X |
| Middle James River | JMSOH | VA | X | X | | | X |
| Chickahominy River | CHKOH | VA | X | X | | | X |
| Lower James River | JMSMH | VA | X | X | | | X |
| Mouth of the James River | JMSPH | VA | | X | | | X |
| Western Branch Elizabeth River | WBEMH | VA | | X | | | |
| Southern Branch Elizabeth River | SBEMH | VA | | X | | | |
| Eastern Branch Elizabeth River | EBEMH | VA | | X | | | |
| Lafayette River | LAFMH | VA | | X | | | |
| Mouth of the Elizabeth River | ELIPH | VA | | X | X | X | |

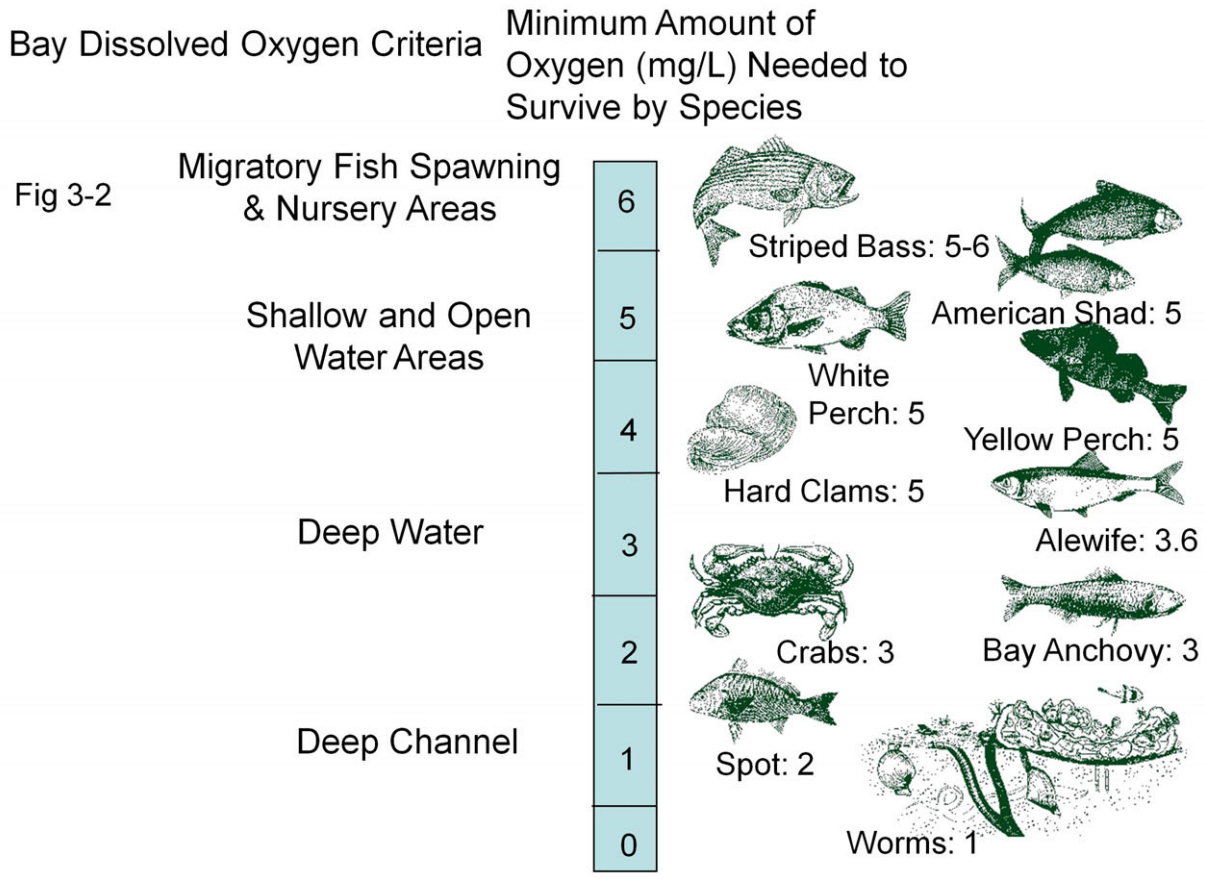
| CB segment name | CB segment | Juris. | Migratory fish spawning & nursery<br>Feb. 1–May 31 | Open water fish & shellfish<br>Year-round | Deep water seasonal fish & shellfish<br>June 1–Sept. 30 | Deep channel seasonal refuge<br>June 1–Sept. 30 | Shallow water Bay grasses<br>SAV growing season |
|---|---|---|---|---|---|---|---|
| Lynnhaven River | LYNPH | VA | | X | | | X |
| Northeast River | NORTF | MD | X | X | | | X |
| C&D Canal, DE | C&DOH_DE | DE | X | X | | | X |
| C&D Canal, MD | C&DOH_MD | MD | X | X | | | X |
| Bohemia River | BOHOH | MD | X | X | | | X |
| Elk River | ELKOH | MD | X | X | | | X |
| Sassafras River | SASOH | MD | X | X | | | X |
| Upper Chester River | CHSTF | MD | X | X | | | X |
| Middle Chester River | CHSOH | MD | X | X | | | X |
| Lower Chester River | CHSMH | MD | X | X | X | X | X |
| Eastern Bay | EASMH | MD | | X | X | X | X |
| Upper Choptank River | CHOTF | MD | X | X | | | |
| Middle Choptank River | CHOOH | MD | X | X | | | X |
| Lower Choptank River | CHOMH2 | MD | X | X | | | X |
| Mouth of the Choptank River | CHOMH1 | MD | X | X | | | X |
| Little Choptank River | LCHMH | MD | | X | | | X |
| Honga River | HNGMH | MD | | X | | | X |
| Fishing Bay | FSBMH | MD | X | X | | | X |
| Upper Nanticoke River, MD | NANTF_MD | MD | X | X | | | |
| Upper Nanticoke River, DE | NANTF_DE | DE | X | X | | | X |
| Middle Nanticoke River | NANOH | MD | X | X | | | X |
| Lower Nanticoke River | NANMH | MD | X | X | | | X |
| Wicomico River | WICMH | MD | X | X | | | X |
| Manokin River | MANMH | MD | X | X | | | X |
| Big Annemessex River | BIGMH | MD | X | X | | | X |
| Upper Pocomoke River | POCTF | MD | X | X | | | |
| Middle Pocomoke River, MD | POCOH_MD | MD | X | X | | | |
| Middle Pocomoke River, VA | POCOH_VA | VA | X | X | | | |
| Lower Pocomoke River, MD | POCMH_MD | MD | X | X | | | X |
| Lower Pocomoke River, VA | POCMH_VA | VA | X | X | | | X |
| Tangier Sound, MD | TANMH_MD | MD | | X | | | X |
| Tangier Sound, VA | TANMH_VA | VA | | X | | | X |

Sources: USEPA 2003d, 2004e, 2007a, 2010a

### 3.1.2 Dissolved Oxygen Criteria

Oxygen is one of the most essential environmental constituents supporting life. In the Chesapeake Bay's deeper waters, there is a natural tendency toward reduced DO conditions because of the Bay's physical morphology and estuarine circulation. The Chesapeake Bay's highly productive shallow waters, coupled with strong density stratification (preventing reaeration); long residence times (weeks to months); low tidal energy; and tendency to retain, recycle, and regenerate nutrients from the surrounding watershed all set the stage for low DO conditions.

Against that backdrop, EPA worked closely with its seven watershed partners and the larger Bay scientific community to derive and publish a set of DO criteria to protect specific aquatic life communities and reflect the Chesapeake Bay's natural processes that define distinct habitats (Figure 3-2) (USEPA 2003a; Batiuk et al. 2009). Working with the National Marine Fisheries Service, EPA also ensured that the DO criteria were protective of the shortnose sturgeon, a species listed as endangered by the Endangered Species Act (NMFS 2003; USEPA 2003b).




Source: USEPA 2003a

**Figure 3-2. Dissolved oxygen concentrations (mg/L) required by different Chesapeake Bay species and biological communities.**

Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (Table 3-4) (USEPA 2003a). Criteria for deep-water seasonal fish and shellfish designated use habitats, during seasons when the water column is significantly stratified, were set at levels to protect juvenile and adult fish, shellfish, and the recruitment success of the Bay anchovy. Criteria for deep-channel seasonal refuge designated use habitats in summer were set to protect the survival of bottom sediment-dwelling worms and clams.

**Table 3-4. Current Chesapeake Bay DO criteria**

| Designated use | Criteria concentration/duration | Protection provided | Temporal application |
|---|---|---|---|
| Migratory fish spawning and nursery use | 7-day mean ≥ 6 mg/L (tidal habitats with 0–0.5 ppt salinity) | Survival and growth of larval/juvenile tidal-fresh resident fish; protective of threatened/endangered species | February 1–May 31 |
| | Instantaneous minimum ≥ 5 mg/L | Survival and growth of larval/juvenile migratory fish; protective of threatened/endangered species | |
| | Open-water fish and shellfish designated use criteria apply | | June 1–January 31 |
| Shallow-water Bay grass use | Open-water fish and shellfish designated use criteria apply | | Year-round |
| Open-water fish and shellfish use | 30-day mean ≥ 5.5 mg/L (tidal habitats with 0–0.5 ppt salinity) | Growth of tidal-fresh juvenile and adult fish; protective of threatened/endangered species | Year-round |
| | 30-day mean ≥ 5 mg/L (tidal habitats with >0.5 ppt salinity) | Growth of larval, juvenile, and adult fish and shellfish; protective of threatened/endangered species | |
| | 7-day mean ≥ 4 mg/L | Survival of open-water fish larvae | |
| | Instantaneous minimum ≥ 3.2 mg/L | Survival of threatened/endangered sturgeon species[a] | |
| Deep-water seasonal fish and shellfish use | 30-day mean ≥ 3 mg/L | Survival and recruitment of Bay anchovy eggs and larvae | June 1–September 30 |
| | 1-day mean ≥ 2.3 mg/L | Survival of open-water juvenile and adult fish | |
| | Instantaneous minimum ≥ 1.7 mg/L | Survival of Bay anchovy eggs and larvae | |
| | Open-water fish and shellfish designated use criteria apply | | October 1–May 31 |
| Deep-channel seasonal refuge use | Instantaneous minimum ≥ 1 mg/L | Survival of bottom-dwelling worms and clams | June 1–September 30 |
| | Open-water fish and shellfish designated use criteria apply | | October 1–May 31 |

Source: USEPA 2003a

Notes: mg/L = milligrams per liter; ppt = parts per thousand salinity

a. At temperatures considered stressful to shortnose sturgeon (> 29 degrees Celsius), DO concentrations above an instantaneous minimum of 4.3 mg/L will protect survival of this listed sturgeon species.

### 3.1.3 Chlorophyll a Criteria

EPA's 2003 Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries (USEPA 2003a) describes the applicable narrative criteria for chlorophyll a:

"Concentrations of chlorophyll *a* in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in ecologically undesirable consequences—such as reduced water clarity, low dissolved oxygen, food supply imbalances, proliferation of species deemed potentially harmful to aquatic life or humans or aesthetically objectionable conditions—or otherwise render tidal waters unsuitable for designated uses."

In 2007 EPA published numeric chlorophyll *a* criteria guidance protective of open-water designated use impairment by harmful algal blooms and provided recommended reference chlorophyll *a* concentrations for historic chlorophyll *a* levels, and DO and water clarity impairments (USEPA 2007b).

Delaware, the District of Columbia, Maryland, and Virginia all adopted EPA's narrative chlorophyll *a* criteria. Additionally, the District of Columbia and Virginia adopted numeric chlorophyll *a* criteria for certain tidal waters as detailed in Sections 3.2.2 and 3.2.7, respectively.

### 3.1.4 Water Clarity/Underwater Bay Grasses Criteria

Underwater bay grass beds create rich animal habitats that support the growth of diverse fish and invertebrate populations. Underwater bay grasses, also referred to as submerged aquatic vegetation (SAV), help improve tidal water quality by retaining nitrogen and phosphorus as plant material, stabilizing bottom sediment (preventing their resuspension) and reducing shoreline erosion. The health and survival of such underwater plant communities in the Chesapeake Bay and its tidal tributaries and embayments depend on suitable environmental conditions (Dennison et al. 1993; Kemp et al. 2004).

The loss of SAV from the shallow waters of the Chesapeake Bay, which was first noted in the early 1960s, is a widespread, well-documented problem (Orth and Moore 1983; Orth et al. 2010b). The primary causes of the decline of SAV are nutrient over-enrichment, increased suspended sediment in the water, and associated reductions in light availability (Kemp et al. 2004). To restore the critical habitats and food sources, enough light must penetrate the shallow waters to support the survival, growth, and repropagation of diverse, healthy, SAV communities (Dennison et al. 1993).

EPA, working closely with its seven watershed partners and the larger Bay scientific community, derived and published Chesapeake Bay water clarity criteria to establish the minimum level of light penetration required to support the survival, growth, and continued propagation of SAV (USEPA 2003a). Chesapeake Bay-specific water clarity criteria were derived for low and higher salinity habitats using a worldwide literature synthesis, an evaluation of Chesapeake Bay-specific field study findings, and application model simulations and diagnostic tools (Table 3-5).

The water clarity criteria, applied only during the SAV growing seasons, are presented in terms of the percent ambient light at the water surface extending through the water column and the

equivalent Secchi depth by application depth (Table 3-5). The recommended percent light-through-water criteria can be directly measured using a Secchi disk or a light meter. A specific application depth is required to apply and determine attainment of the water clarity criteria (Table 3-6).

SAV restoration acreage goals and water clarity application depths were developed based on historic and recent data on the distribution of SAV (USEPA 2003d). Detailed analyses using that data—including historical aerial photographs—were undertaken to map the distribution and depth of historical SAV beds in the Chesapeake Bay and its tidal tributaries and embayments. The analyses led to the adoption of the single best year method that considers historical SAV distributions from the 1930s through the early 1970s and more recent distributions since 1978 to the present mapped through annual SAV aerial surveys of the Bay's shallow-water habitats. Using that method, the EPA and its watershed partners established a Bay-wide SAV restoration goal of 185,000 acres and Bay segment-specific acreage goals (Table 3-6) (USEPA 2003d).

**Table 3-5. Summary of Chesapeake Bay water clarity criteria for application to shallow-water Bay grass designated use habitats**

| Salinity regime[b] | Water clarity criteria (percent light-through-water) | Water clarity criteria as Secchi depth[a] | | | | | | | | Temporal application |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Water clarity criteria application depths (meters) | | | | | | | | |
| | | 0.25 | 0.5 | 0.75 | 1.0 | 1.25 | 1.5 | 1.75 | 2.0 | |
| | | Secchi depth for above criteria application depth (meters) | | | | | | | | |
| Tidal-fresh | 13% | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 | 1.2 | 1.4 | April 1–Oct 31 |
| Oligohaline | 13% | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 | 1.2 | 1.4 | April 1–Oct 31 |
| Mesohaline | 22% | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.4 | 1.7 | 1.9 | April 1–Oct 31 |
| Polyhaline | 22% | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.4 | 1.7 | 1.9 | March 1–May 31<br>Sept 1–Nov 30 |

Source: USEPA 2003a

a. Based on application of the Equation IV-1 published in USEPA 2003a, PLW = $100\exp(-K_dZ)$, where the appropriate percent light through water (PLW) criterion value and the selected application depth (see Table 3-6) are inserted and the equation is solved for $K_d$. The generated $K_d$ value is then converted to Secchi depth (in meters) using the conversion factor $K_d = 1.45/\text{Secchi depth}$.

b. Tidal fresh = 0-0.5 ppt salinity; oligohaline = >0.5-5 ppt salinity; mesohaline = >5-18 ppt salinity; polyhaline = >18 ppt salinity

**Table 3-6. Chesapeake Bay SAV restoration acreage goals and application depths**

| Segment description | State | Segment designator | SAV acreage restoration goal (acres) | Application depth (meters) |
|---|---|---|---|---|
| Northern Chesapeake Bay | MD | CB1TF2 | 12,149 | 2.0 |
| Northern Chesapeake Bay | MD | CB1TF1 | 754 | 1.0 |
| Upper Chesapeake Bay | MD | CB2OH | 705 | 0.5 |
| Upper Central Chesapeake Bay | MD | CB3MH | 1,370 | 0.5 |
| Middle Central Chesapeake Bay | MD | CB4MH | 2,533 | 2.0 |
| Lower Central Chesapeake Bay | MD | CB5MH_MD | 8,270 | 2.0 |
| Lower Central Chesapeake Bay | VA | CB5MH_VA | 7,633 | 2.0 |
| Western Lower Chesapeake Bay | VA | CB6PH | 1,267 | 1.0 |

| Segment description | State | Segment designator | SAV acreage restoration goal (acres) | Application depth (meters) |
|---|---|---|---|---|
| Eastern Lower Chesapeake Bay | VA | CB7PH | 15,107 | 2.0 |
| Mouth of Chesapeake Bay | VA | CB8PH | 11 | 0.5 |
| Bush River | MD | BSHOH | 350 | 0.5 |
| Gunpowder River-Upper | MD | GUNOH2 | 572 | 2.0 |
| Gunpowder River-Lower | MD | GUNOH1 | 1,860 | 0.5 |
| Middle River | MD | MIDOH | 879 | 2.0 |
| Back River | MD | BACOH | 30 | 0.5 |
| Patapsco River | MD | PATMH | 389 | 1.0 |
| Magothy | MD | MAGMH | 579 | 1.0 |
| Severn River | MD | SEVMH | 455 | 1.0 |
| South River | MD | SOUMH | 479 | 1.0 |
| Rhode River | MD | RHDMH | 60 | 0.5 |
| West River | MD | WSTMH | 238 | 0.5 |
| Upper Patuxent River | MD | PAXTF | 205 | 0.5 |
| Middle Patuxent River | MD | PAXOH | 115 | 0.5 |
| Lower Patuxent River | MD | PAXMH1 | 1,459 | 2.0 |
| Lower Patuxent River | MD | PAXMH2 | 172 | 0.5 |
| Lower Patuxent River | MD | PAXMH4 | 1 | 0.5 |
| Lower Patuxent River | MD | PAXMH5 | 2 | 0.5 |
| Upper Potomac River | MD | POTTF_MD | 2,142 | 2.0 |
| Piscataway Creek | MD | PISTF | 789 | 2.0 |
| Mattawoman Creek | MD | MATTF | 792 | 1.0 |
| Middle Potomac River | MD | POTOH1 | 1,387 | 2.0 |
| Middle Potomac River | MD | POTOH2 | 262 | 1.0 |
| Middle Potomac River | MD | POTOH3 | 1,153 | 1.0 |
| Lower Potomac River | MD | POTMH_MD | 7,088 | 1.0 |
| Upper Potomac River | VA | POTTF_VA | 2,093 | 2.0 |
| Middle Potomac River | VA | POTOH_VA | 1,503 | 2.0 |
| Lower Potomac River | VA | POTMH_VA | 4,250 | 1.0 |
| Upper Rappahannock River | VA | RPPTF | 66 | 0.5 |
| Middle Rappahannock River | VA | RPPOH | 4 | 0.5 |
| Lower Rappahannock River | VA | RPPMH | 1,700 | 1.0 |
| Corrotoman River | VA | CRRMH | 768 | 1.0 |
| Piankatank River | VA | PIAMH | 3,479 | 2.0 |
| Upper Mattaponi River | VA | MPNTF | 85 | 0.5 |
| Upper Pamunkey River | VA | PMKTF | 187 | 0.5 |
| Middle York River | VA | YRKMH | 239 | 0.5 |
| Lower York River | VA | YRKPH | 2,793 | 1.0 |
| Mobjack Bay | VA | MOBPH | 15,901 | 2.0 |
| Upper James River-Upper | VA | JMSTF2 | 200 | 0.5 |
| Upper James River-Lower | VA | JMSTF1 | 1,000 | 0.5 |
| Appomattox River | VA | APPTF | 379 | 0.5 |
| Middle James River | VA | JMSOH | 15 | 0.5 |

| Segment description | State | Segment designator | SAV acreage restoration goal (acres) | Application depth (meters) |
|---|---|---|---|---|
| Chickahominy River | VA | CHKOH | 535 | 0.5 |
| Lower James River | VA | JMSMH | 200 | 0.5 |
| Mouth of the James River | VA | JMSPH | 300 | 1.0 |
| Lynnhaven River | VA | LYNPH | 107 | 0.5 |
| Northeast River | MD | NORTF | 89 | 0.5 |
| Chesapeake & Delaware Canal | MD | C&DOH_MD | 7 | 0.5 |
| Bohemia River | MD | BOHOH | 354 | 0.5 |
| Elk River | MD | ELKOH1 | 1,844 | 2.0 |
| Elk River | MD | ELKOH2 | 190 | 0.5 |
| Sassafras River | MD | SASOH1 | 1,073 | 2.0 |
| Sassafras River | MD | SASOH2 | 95 | 0.5 |
| Upper Chester River | MD | CHSTF | 1 | 0.5 |
| Middle Chester River | MD | CHSOH | 77 | 0.5 |
| Lower Chester River | MD | CHSMH | 2,928 | 1.0 |
| Eastern Bay | MD | EASMH | 6,209 | 2.0 |
| Middle Choptank River | MD | CHOOH | 72 | 0.5 |
| Lower Choptank River | MD | CHOMH2 | 1,621 | 1.0 |
| Mouth of Choptank River | MD | CHOMH1 | 8,184 | 2.0 |
| Little Choptank River | MD | LCHMH | 4,076 | 2.0 |
| Honga River | MD | HNGMH | 7,761 | 2.0 |
| Fishing Bay | MD | FSBMH | 197 | 0.5 |
| Middle Nanticoke River | MD | NANOH | 12 | 0.5 |
| Lower Nanticoke River | MD | NANMH | 3 | 0.5 |
| Wicomico River | MD | WICMH | 3 | 0.5 |
| Manokin River | MD | MANMH1 | 4,294 | 2.0 |
| Manokin River | MD | MANMH2 | 59 | 0.5 |
| Big Annemessex River | MD | BIGMH1 | 2,021 | 2.0 |
| Big Annemessex River | MD | BIGMH2 | 22 | 0.5 |
| Lower Pocomoke River | MD | POCMH_MD | 877 | 1.0 |
| Lower Pocomoke River | VA | POCMH_VA | 4,066 | 1.0 |
| Tangier Sound | MD | TANMH1_MD | 24,683 | 2.0 |
| Tangier Sound | MD | TANMH2_MD | 74 | 0.5 |
| Tangier Sound | VA | TAHMH_VA | 13,579 | 2.0 |

Sources: USEPA 2003d, 2004e; Code of Maryland Title 26 Subtitle 08, Chapter 2, Section 3; Code of Virginia 9 62.1-44.15 3a; VAC 25-260-185; 7 Delaware Code section 6010; 7 Delaware Administrative Code 7401; District of Columbia Municipal Regulations Title 21, Chapter 11.

Notes: This table contains additional split segments beyond the 92 Chesapeake Bay segments listed in Table 3-3 strictly for purposes of applying separate water clarity criteria application depths within the same Bay segment (USEPA 2004e). If a Bay segment was listed in Table 3-3, but it is not listed here, that entire Bay segment has been delineated as a SAV no-grow zone and the shallow-water bay grass does not apply (USEPA 2004e).

## 3.2 JURISDICTIONS' CURRENT CHESAPEAKE BAY WATER QUALITY STANDARDS REGULATIONS

Delaware, the District of Columbia, Maryland, and Virginia each has adopted WQS consistent with EPA's published Chesapeake Bay water quality criteria, assessment procedures, and tidal water designated uses in its respective WQS regulations (Table 3-7). In some cases, a jurisdiction also adopted jurisdiction-specific designated uses or criteria or both; those cases are briefly described below.

**Table 3-7. Links for accessing the current waters quality standards (WQS) regulations for Delaware, the District of Columbia, Maryland, and Virginia**

| Jurisdiction | WQS regulations URL address |
|---|---|
| Delaware | 7 Delaware Code Section 6010; 7 Delaware Administrative Code 7401 <http://www.epa.gov/waterscience/standards/wqslibrary/de/de_3_wqs.pdf> |
| District of Columbia | DC Municipal Regulations Title 21, Chapter 11 <http://www.epa.gov/waterscience/standards/wqslibrary/dc/dc_3_register.pdf> |
| Maryland | Code of Maryland Title 26 Subtitle 08, Chapter 2 <http://www.epa.gov/waterscience/standards/wqslibrary/dsd.state.md/md-ch2-quality-20051130.pdf.us/comar/subtitle_chapters/26_Chapters.htm> |
| Virginia | Code of Virginia 9 62.1-44.15 3a; VAC 25-260 Virginia WQSs <http://www.deq.virginia.gov/wqs/> OR <http://epa.gov/waterscience/standards/wqslibrary/va/va_3_wqs.pdf> |

### 3.2.1 Delaware

Delaware has adopted all the EPA-published Chesapeake Bay criteria, assessment procedures, designated use documents, and subsequent addenda listed in Table 3-1 by reference into its WQS regulations. The EPA-published Chesapeake Bay criteria, assessment procedures, and designated use documents and subsequent addenda apply to the tidal Nanticoke River and Broad Creek in Delaware, both of which are subject to this Chesapeake Bay TMDL (see Table 2-1). Delaware has also adopted EPA's narrative chlorophyll *a* water quality criteria.

### 3.2.2 District of Columbia

The District of Columbia has adopted all the EPA-published Chesapeake Bay criteria, assessment procedures, designated use documents, and subsequent addenda listed in Table 3-1 by reference into its WQS regulations. Table 3-8 summarizes the District of Columbia's designated uses for its surface waters. The District of Columbia has adopted EPA's narrative chlorophyll *a* water quality criteria but also adopted the numeric chlorophyll *a* water quality criteria shown in Table 3-9 with respect to the District of Columbia's tidal Class C waters (those designated for the protection and propagation of fish, shellfish, and wildlife). Those numeric chlorophyll *a* criteria are subject to this Chesapeake Bay TMDL (see Table 2-1).

**Table 3-8. District of Columbia designated uses for surface waters**

| Class of water | Description |
|---|---|
| A | Primary contact recreation |
| B | Secondary contact recreation and aesthetic enjoyment |
| C | Protection and propagation of fish, shellfish, and wildlife |
| D | Protection of human health related to consumption of fish and shellfish |
| E | Navigation |

Source: District of Columbia Municipal Regulations Title 21, Chapter 11

**Table 3-9. Numeric criteria for the District of Columbia's tidally influenced waters**

| Constituent | Numeric criteria | Temporal application | Designated use |
|---|---|---|---|
| Dissolved oxygen | 7-day mean ≥ 6.0 mg/L<br>Instantaneous minimum ≥ 5.0 mg/L<br><br>30-day mean ≥ 5.5 mg/L<br><br>7-day mean ≥ 4.0 mg/L<br>Instantaneous minimum ≥ 3.2 mg/L<br>(At temperatures > 29 °C, in tidally influenced waters, an instantaneous minimum DO concentration of 4.3 mg/L will apply) | February 1–May 31<br><br>June 1–January 31 | C |
| Secchi depth | 0.8 m (seasonal segment average) | April 1–October 31 | C |
| Chlorophyll *a* | 25 µg/L (season segment average) | July 1–September 30 | C |

Source: District of Columbia Municipal Regulations Title 21, Chapter 11
Note: µg/L = micrograms per liter

### 3.2.3 Maryland

Maryland has adopted into its WQS regulations all the EPA-published Chesapeake Bay criteria, assessment procedures, and designated uses documents, and subsequent addenda listed in Table 3-1. These WQS apply to all Chesapeake Bay, tidal tributary and embayment waters of Maryland, all of which are subject to this Chesapeake Bay TMDL (see Table 2-1). Maryland has also adopted EPA's narrative chlorophyll *a* water quality criteria.

Several tidal Bay segment-specific applications of DO criteria are unique to Maryland. In the middle-central Chesapeake Bay segment (CB4MH), restoration variances[1] of 7 and 2 percent apply to the application of the deep-water and deep-channel designated use DO criteria, respectively. In the Patapsco River segment (PATMH), a restoration variance of 7 percent applies to the application of the deep-water designated use DO criteria. In the lower Chester River segment (CSHMH), a restoration variance of 14 percent applies to the application of the deep-channel designated use DO criterion (COMAR 26.08.02.03-3(c)(8)(e)(vi). These restoration variances are consistent with EPA-published guidance (USEPA 2003d) and were

[1] A restoration variance is the percentage of allowable exceedance of a WQS based on water quality modeling incorporating the best available data and assumptions. The restoration variances are temporary and will be reviewed at a minimum every 3 years, as required by the CWA and EPA regulations. The variances could be modified on the basis of new data or assumptions incorporated into the water quality model. COMAR 26.08.02.03-3(C)(8)(h).

approved by EPA on August 29, 2005 in the case of the two mainstem Bay and Patapsco River segments and December 27, 2010 in the case of the lower Chester River segment.

In the tidal upper and middle Pocomoke River segments (POCTF, POCOH_MD), because of the seasonal lower DO concentration from the natural oxygen-depleting processes present in the extensive surrounding tidal wetlands, Maryland adopted a site-specific criterion of greater than or equal to 4 mg/L 30-day mean DO, consistent with the EPA-published criterion (USEPA 2004a), and approved by EPA on December 27, 2010.

### 3.2.4 Virginia

Virginia has adopted into its WQS regulations all the EPA-published Bay criteria, assessment procedures, designated uses documents, and subsequent addenda listed in Table 3-1. These WQS apply to all Chesapeake Bay, tidal tributary and embayment waters of Virginia, all of which are subject to this Chesapeake Bay TMDL. The narrative chlorophyll *a* criteria guidance published by EPA (USEPA 2003a) was adopted by Virginia for application to Virginia's Bay tidal waters. Virginia also adopted the segment-specific numeric chlorophyll *a* criteria for the tidal James River listed in Table 3-10 into its WQS regulations. The criteria are based on various scientific lines of evidence published in the original EPA 2003 Bay criteria document (USEPA 2003a) with additional river-specific considerations (VADEQ 2004). EPA approved Virginia's WQS regulations on June 27, 2005 and approved additional amendments on December 28, 2010.

**Table 3-10. Segment-specific chlorophyll *a* criteria for Virginia's tidal James River waters**

| Designated use | Chlorophyll *a* criterion (µg/L) | Chesapeake Bay segment | Temporal application |
|---|---|---|---|
| Open-Water | 10 | Upper James River-Upper (JMSTF2) | March 1–May 31 |
| | 15 | Upper James River-Lower (JMSTF1) | |
| | 15 | Middle James River (JMSOH) | |
| | 12 | Lower James River (JMSMH) | |
| | 12 | Mouth of the James River (JMSPH) | |
| | 15 | Upper James River-Upper (JMSTF2) | July 1–September 30 |
| | 23 | Upper James River-Lower (JMSTF1) | |
| | 22 | Middle James River (JMSOH) | |
| | 10 | Lower James River (JMSMH) | |
| | 10 | Mouth of the James River (JMSPH) | |

Source: Code of Virginia 9 section 62.1-44.15 3a; VAC 25-260
Note: µg/L = micrograms per liter

Virginia has additional site-specific DO and chlorophyll *a* criteria. In the tidal Mattaponi (MPNTF, MPNOH) and Pamunkey (PMKTF, PMKOH) river segments, because of the seasonal lower DO concentration from the natural oxygen-depleting processes present in the surrounding extensive tidal wetlands, Virginia adopted a site-specific criterion of greater than or equal to 4 mg/L 30-day mean DO (9 VAC 25-260-185), consistent with the EPA-published criterion (USEPA 2004a) and approved by EPA on June 27, 2005.

## 3.3 ASSESSING ATTAINMENT OF CHESAPEAKE BAY WATER QUALITY STANDARDS

The Bay criteria assessment approach is designed to protect the living resources as defined by the designated uses (USEPA 2003a). The criteria levels themselves were largely based on scientific studies performed in laboratory settings or under controlled field conditions. The criteria establish the level of a given habitat condition that living resources need for survival. They do not account for many other environmental factors that could affect survival.

For all four tidal jurisdictions, attainment of each jurisdiction's Chesapeake Bay WQS is determined by applying the same set of assessment procedures published in the original 2003 Chesapeake Bay criteria document (USEPA 2003a) and subsequent published addenda (USEPA 2004a, 2007a, 2007b, 2008a, 2010a) (see Table 3-1). Those consistent sets of criteria assessment procedures were formally adopted into each jurisdiction's WQS regulations by reference.

### *3.3.1 Defining Total Exceedances*

Criteria attainment for DO, water clarity, and chlorophyll *a* is assessed in terms of the spatial and temporal extent of criterion exceedances—what volume or surface area of the Bay segment exceeds a given criterion and for how much time during the assessment period (USEPA 2003a, 2004a). The allowable frequency with which criteria can be violated without a loss of the designated use is also considered. For each listing cycle, assessments are based on monitoring data collected over a 3-year period in each spatial assessment unit. Spatial assessment units are defined by Chesapeake Bay segments and applicable designated uses. Such assessment of the criteria as further described below is designed to provide reliable protection for the associated refined aquatic life use.

The spatial exceedances of criteria are determined using a grid cell-based data interpolation software application that enables estimation of water quality values for the entire Bay using monitored data at specific points (USEPA 2003a, 2007a). The interpolated data are compared to water quality criteria on a cell by cell basis, and the percent of surface area or volume exceeding the criterion in each spatial assessment unit is calculated. The percent spatial exceedances for each assessment unit are then compiled for each monitoring event conducted during the 3-year monitoring period.

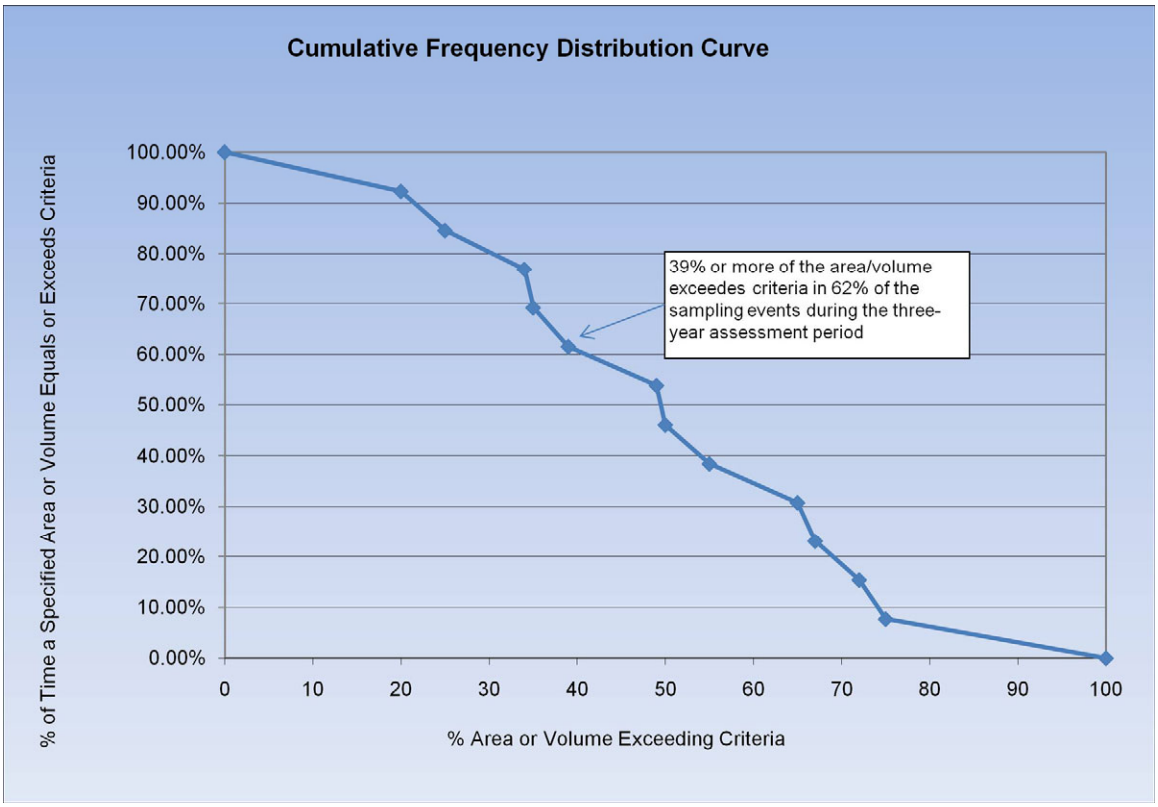
The temporal extent of exceedances is determined by calculating the probability that an observed percent exceedance will be equaled or exceeded. To calculate that probability, the percent of spatial exceedances are sorted and ranked, and a cumulative probability is calculated for each spatial exceedance value (USEPA 2003a). An example is shown in Table 3-11.

The spatial and temporal exceedances can be graphically illustrated by plotting the cumulative frequency distribution (CFD) curve, which is a plot of the temporal exceedance values on the Y-axis versus the spatial exceedance values (in area or volume) on the X-axis (Figure 3-3) (USEPA 2003a, 2007a; STAC 2006).

**Table 3-11. Estimated percent spatial criteria exceedances and associated cumulative probabilities**

| Period of data | Percent area/volume exceeding criteria (spatial) | Rank | Cumulative probability [rank / (n + 1)] (temporal) |
|---|---|---|---|
| | 100 | | 0.00% |
| June 1998 | 75 | 1 | 7.69% |
| March 1998 | 72 | 2 | 15.38% |
| May 1999 | 67 | 3 | 23.08% |
| May 1998 | 65 | 4 | 30.77% |
| April 1998 | 55 | 5 | 38.46% |
| June 2000 | 50 | 6 | 46.15% |
| March 1999 | 49 | 7 | 53.85% |
| April 2000 | 39 | 8 | 61.54% |
| May 2000 | 35 | 9 | 69.23% |
| Apr 1999 | 34 | 10 | 76.92% |
| June 1999 | 25 | 11 | 84.62% |
| March 2000 | 20 | 12 | 92.31% |

Source: USEPA 2003a




Source: USEPA 2003a

**Figure 3-3. Example cumulative frequency distribution (CFD) curve.**

### 3.3.2 Defining Allowable Exceedances

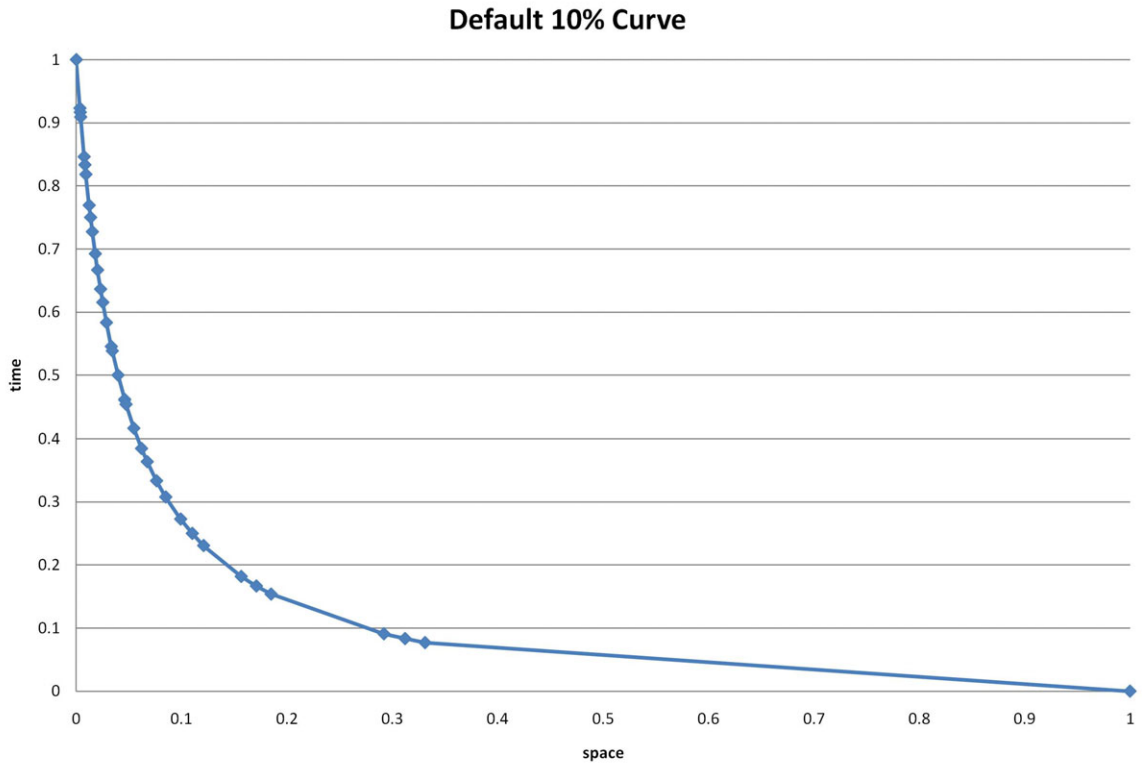
EPA developed reference curves for each water quality criterion (DO, water clarity, and chlorophyll *a*) to provide a scientifically based, direct measure of the time and space during which a particular criterion can be allowably exceeded – i.e., without resulting in harm to the designated uses(s) (USEPA 2003a). Those allowable exceedances are defined to be those that last a short enough time or cover a small enough volume/surface area to have no adverse effects on the designated use. It is assumed that the designated uses can be attained even with some limited level of criteria exceedances and, thus, the reference curves define those criteria exceedances deemed to be allowable—chronic in time but over small volumes/surface areas, or infrequent occurrences over large volumes/surface areas. Exceedances that occur over large areas of space and time would be expected to have significant detrimental effects on biological communities, which would imply nonattainment of designated uses.

For assessment purposes, EPA developed two types of reference curves: a biological reference curve and a 10 percent default reference curve for use when a biological reference curve is unavailable.

Biological reference curves are CFDs developed for a given criterion in areas for which monitoring data are available and in which healthy aquatic communities exist (USEPA 2003a). They represent the range of conditions that can reasonably be expected in a healthy community. As a result, the biological reference curve can be used to provide an understanding of what level of criteria exceedances are allowable without losing support of the designated use. Given the Bay's nutrient-enriched status, however, appropriate reference sites are limited. Biological reference curves have been published for and are used to assess allowable exceedances for the deep-water DO criteria (USEPA 2010a) and the water clarity criteria (USEPA 2003a).

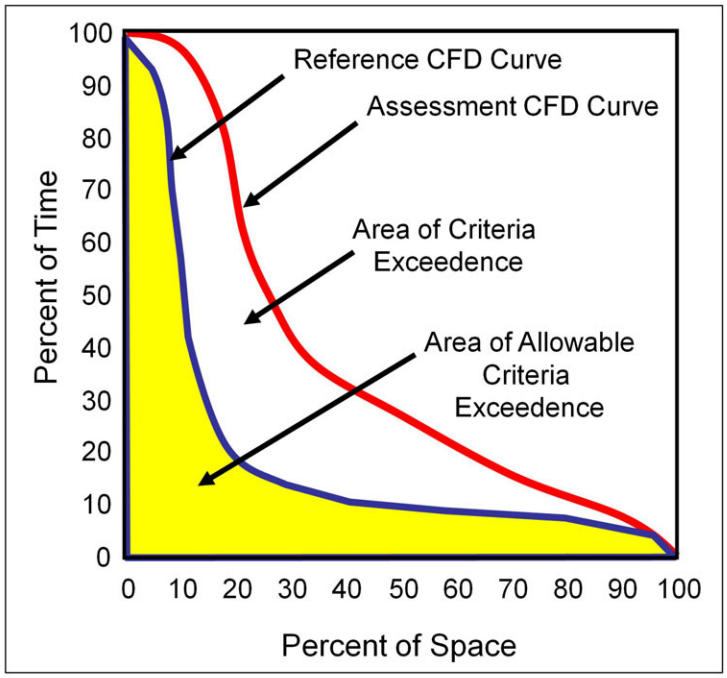
In some cases, developing a biologically based reference curve is not possible because of a lack of data describing the health of the relevant species or biological communities and lack of appropriate reference sites. In those cases, EPA used a 10 percent default reference curve (USEPA 2007a). The 10 percent default reference curve is defined as a hyperbolic curve that encompasses no more than 10 percent of the area of the CFD graph (percent of space multiplied by percent of time) (USEPA 2007a, page 13, Figure II-4 and Equation 1) (Figure 3-4).

Once the CFD curve for a spatial assessment unit is developed from monitoring data (also referred to as the assessment curve), it is compared to the appropriate reference curve. The area on the graph above the reference curve (blue line) and below the assessment curve (red line) is considered a non-allowable exceedance. The area below the reference curve (yellow) is considered an allowable exceedance (Figure 3-5).




Source: USEPA 2007a

**Figure 3-4. Default reference curve used in the attainment assessment of Chesapeake Bay water quality criteria for which biologically based reference curves have not yet been derived.**




Source: USEPA 2003a

**Figure 3-5. Example reference and assessment curves showing allowable and non-allowable exceedances.**

### 3.3.3 Assessing Criteria Attainment

#### Dissolved Oxygen Criteria Assessment

EPA published DO criteria protective of migratory fish spawning and nursery, open-water fish and shellfish, deep-water seasonal fish and shellfish, and deep-channel seasonal refuge designated use habitats. DO criteria were established for the Chesapeake Bay that varied in space and time to provide levels of protection for different key species and communities (Table 3-4). The criteria also were designed around several lengths of time to reflect the varying oxygen tolerances for different life stages (e.g., larval, juvenile, adult) and effects (e.g., mortality, growth, behavior) (USEPA 2003a).

The DO criteria include multiple components, including the target DO concentration, the duration of time over which the concentration is averaged, the designated use area where the criterion applies, the protection provided, and the time of year when the criterion applies (USEPA 2003a, 2003d). The four tidal Bay jurisdictions adopted these DO criteria into their respective WQS regulations.

Assessing DO criteria attainment is challenging because of the complexity of both the criteria and the Bay itself. To fully assess all the criteria components, data needed to be collected at a spatial intensity that adequately represents the four designated use habitats of Chesapeake Bay tidal waters at different times of the year (USEPA 2003c, 2004e). Similarly, data were collected during all the applicable seasons and at frequencies sufficient to address the various criteria duration components.

The different DO criteria apply to different designated use areas and multiple criteria apply to the same designated use area. The DO criteria components also apply over different periods to protect species during critical life stages or during particularly stressful times of the year. To fully assess each DO component in each designated use habitat over the appropriate periods will require an extensive monitoring program and a detailed assessment methodology. The CBP conducts extensive water quality and living resource monitoring throughout the Bay tidal waters (CBP 1989a, 1989b; MRAT 2009). The existing Bay water quality monitoring was not sufficient to cover all the criteria components, however, and some details in the assessment methodology remain unresolved (USEPA 2007a; MRAT 2009).

The DO criteria include 30-day, 7-day, and 1-day means along with an instantaneous minimum. The CBP partners have the capacity (data, published assessment methodology) to assess only the 30-day mean open-water and deep-water DO criteria and, in the case of the deep-channel use, the instantaneous minimum DO criteria (USEPA 2003a, 2004a, 2007a, 2008a, 2010a). The remaining DO criteria were not assessed because the existing water quality monitoring programs and the published assessment methodologies are not yet adequate for full assessment.

Evaluation of the Chesapeake Bay Water Quality and Sediment Transport Model's outputs have provided clear evidence that the 30-day mean open-water and deep-water and the instantaneous minimum deep-channel DO criteria are the criteria driving determination of nutrient loadings supporting attainment all the open-water (30-day mean, 7-day mean, instantaneous minimum), deep-water (30-day mean, 1-day and instantaneous minimum), and deep-channel (instantaneous minimum) DO criteria.

For both open-water and deep–water designated uses, the 30-day mean criteria had the highest nonattainment in all three scenarios illustrated in Figure 3-6. The 30-day mean open-water and deep-water criteria are, therefore, protective of the other non-assessed DO criteria (open-water 7-day and instantaneous minimum, deep-water 1-day mean and instantaneous minimum) on average for the mainstem Bay segments. The deep–channel designated use has only one DO criterion, and it is currently assessed using monitoring data. The deep-channel criterion is also more protective, based on the levels of nonattainment recorded in Figure 3-6, than the deep-water and open-water criteria. The analyses documented in Appendix D provide clear evidence the 30-day mean open-water, 30-day mean deep-water DO criteria, and the deep-channel instantaneous minimum criterion are the most protective criteria across all Bay segments and designated uses.

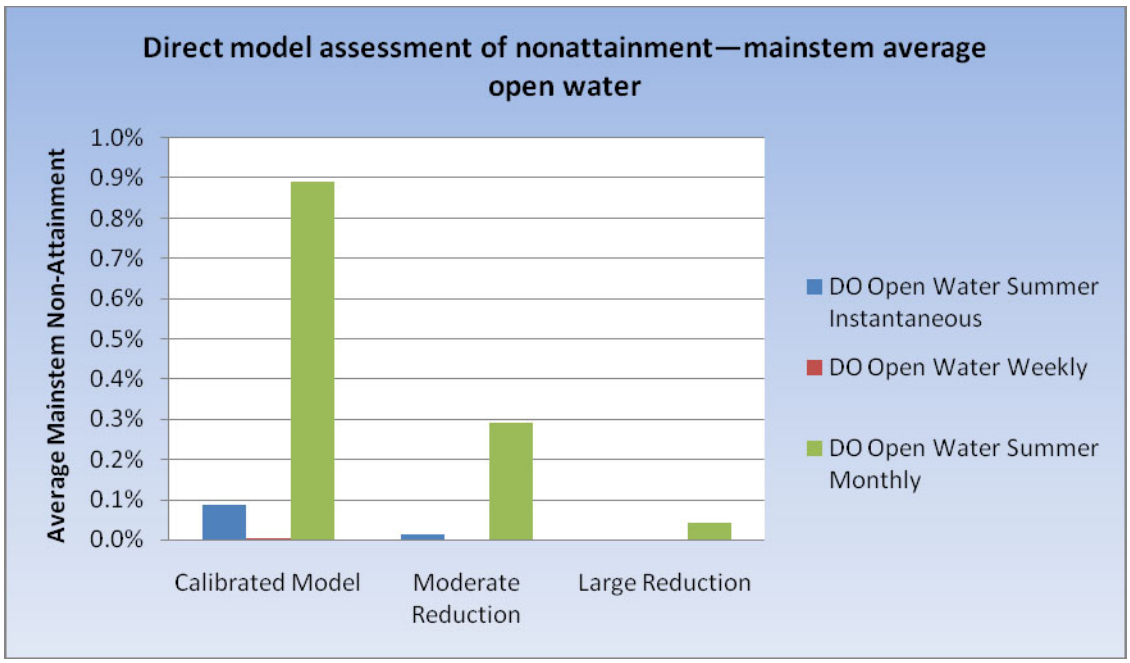
### Chlorophyll *a* Criteria Assessment

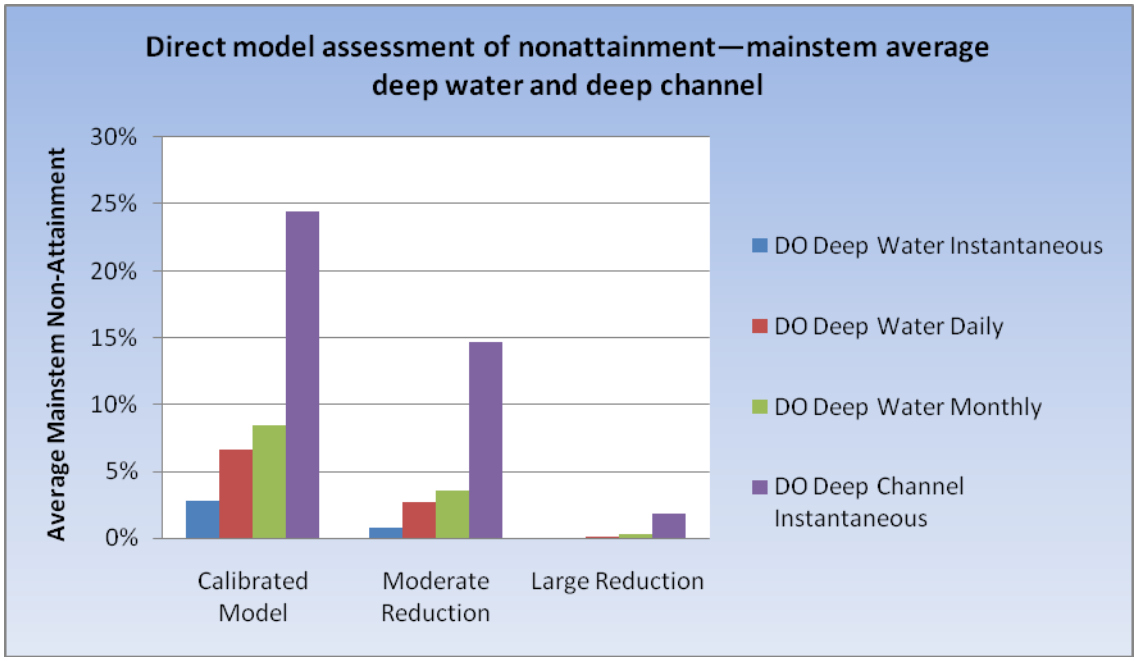
The procedures described in USEPA 2007b, and further refined in USEPA 2010a, apply to assessing Virginia's tidal James River and the District of Columbia's tidal waters numeric chlorophyll *a* criteria.

To assess attainment of the Virginia and the District of Columbia's adopted numerical chlorophyll *a* concentration-based criteria, it was necessary to establish a reference curve for use in the CFD criteria assessment (USEPA 2003a, 2007a). In the case of the numerical chlorophyll *a* criteria where a biologically based reference curve is not available (USEPA 2007b), EPA recommends—and Virginia and the District of Columbia adopted—using the 10 percent default reference curve originally described in USEPA 2007a and illustrated in Figure 3-4.

The jurisdiction-adopted, concentration-based chlorophyll *a* criteria values are threshold concentrations that should be exceeded infrequently (< 10 percent) because a low number of naturally occurring exceedances occur even in a healthy phytoplankton population (USEPA 2007b). The assessment of chlorophyll *a* criteria attainment, therefore, uses the CFD-based assessment method described earlier that applies the 10 percent default reference curve. Such concentration-based Chesapeake Bay chlorophyll *a* criteria apply only to those seasons and salinity-based habitats for which they were defined to protect against applicable human health and aquatic life impairments (USEPA 2007b). Each season—Spring (March 1–May 31) and Summer (July 1–September 30)—was assessed separately to evaluate chlorophyll *a* criteria attainment.

The chlorophyll *a* criteria are based on seasonal means of observed chlorophyll data. The observed data are first transformed by taking the natural logarithm and then interpolated spatially to equally spaced points (representing interpolator cells) within the designated use area for each monitoring cruise. The interpolated value of each cell is averaged in time across the entire season, and then the spatial violation rate is calculated as the fraction of interpolator cells in a designated use area that fails the appropriate criterion (USEPA 2010a).




Source: Appendix D

**Figure 3-6. Direct model assessment of open water (a), and deep water and deep channel (b) criteria.**

### SAV/Water Clarity Criteria Assessment

Water clarity criteria and SAV restoration acreages are used to define attainment of the shallow-water Bay grass designated use in the Chesapeake Bay, its tidal tributaries and embayments (USEPA 2003a, 2003d). EPA published three measures for assessing attainment of the shallow-water SAV designated use for a Chesapeake Bay segment (USEPA 2007a):

1. Measure SAV acreage in the Bay segment from overflight data mapping analysis and compare with the SAV restoration goal acreage for that Bay segment (USEPA 2003d).
2. Measure water clarity acreage on the basis of routine water quality mapping using data from the Chesapeake Bay shallow-water monitoring program and, combined with measured acres of SAV, compare with the calculated water clarity acres for that segment (USEPA 2007a).
3. Measure water clarity criteria attainment on the basis of the CFD assessment methodology, again, using shallow-water monitoring program data (USEPA 2003a, 2003d, 2007a, 2008a).

Without sufficient shallow-water monitoring data to determine the available water clarity acres (measurement 2 above) or to assess water clarity criteria attainment using the CFD-based procedure (measurement 3 above), EPA recommends that the jurisdictions assess shallow-water Bay grass designated use attainment using the acres of mapped SAV (measurement 1 above) (USEPA 2003a, 2003d, 2007a, 2008a).