

SECTION 11. PUBLIC PARTICIPATION

EPA and the Bay jurisdictions have benefitted from a comprehensive effort to exchange information with key stakeholders and the broader public on the Chesapeake Bay TMDL.

The Bay TMDL has been the subject of public discussion and close interaction between EPA and the seven watershed jurisdictions since 2005. Activities to further public involvement in the Bay TMDL will continue in 2011 and beyond as the TMDL is implemented.

The concentrated outreach period of 2009 and 2010 leading up to the establishment of the TMDL is of particular focus in this section. That 2-year effort featured hundreds of meetings with interested groups; two extensive rounds of public meetings, stakeholder sessions, and media interviews throughout the watershed; a dedicated EPA website; a series of monthly interactive webinars accessed online by more than 2,500 people; three 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 states and the District of Columbia have also involved stakeholders and the broader public in the development of their Watershed Implementation Plans, which informed the Bay TMDL.

11.1 Stakeholder and Local Government Outreach and Involvement

EPA has made a concerted effort over the past years to involve a variety of stakeholders, including local governments, in the development of the Chesapeake Bay TMDL. This subsection describes some of the more significant aspects of that effort.

11.1.1 Open Collaboration with Stakeholders

EPA has taken extra efforts to reach out to groups and sectors that will be particularly affected by the Bay TMDL. Since 2008, EPA principals involved in developing the Bay TMDL have attended nearly 400 meetings with a wide range of groups throughout the watershed to give and receive information about the TMDL. A list of those meetings is provided in Appendix C.

During the course of months-long outreach campaigns in the fall of 2009 and 2010, EPA teams conducted nearly 100 separate meetings and briefings with key stakeholder groups to share sector-specific information and address sector-focused questions. Those groups included farmers and producers, homebuilders and developers, municipal wastewater authorities, local elected officials, conservation groups, and environmental advocacy organizations. The outreach generated key insights and perspectives.

11.1.2 Outreach to Local Governments and Elected Officials

EPA and the watershed jurisdictions have made a special effort to involve local governments in the Bay TMDL process to better understand how the TMDL can best be tailored to local scales for implementation. EPA and the jurisdictions will have more targeted discussions with local officials starting in 2011 as the Phase II Watershed Implementation Plans from the states and the

District offer a finer scale commitment to meeting the pollution reduction allocations. EPA has and is willing to use the scientific ability in the TMDL to identify pollution sources and impacts on a relatively local level.

11.1.3 Local Pilots

EPA provided \$300,000 in technical assistance for a series of pilot projects to help the jurisdictions engage local partners as part of their Watershed Implementation plan Process. Local governments, conservation districts, watershed groups and others were eligible for a share of the assistance. The projects are demonstrating how local needs, priorities, and existing restoration efforts can be incorporated in the implementation plans. EPA awarded funds to the following communities and watersheds:

District of Columbia

Maryland: Anne Arundel and Caroline counties

New York: Chemung River watershed

Pennsylvania: Conewago Creek watershed

Virginia: Prince William County and Rivanna River basin

West Virginia: Berkeley, Jefferson, and Morgan counties

Information on the pilot projects is at

http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/WIPPilotProjectSummary_82010.pdf.

11.2 Public Outreach

EPA's extensive outreach efforts included public meetings, webinars, and a dedicated website that facilitated a continuing dialogue between EPA, the seven watershed jurisdictions, and key stakeholders on the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment.

11.2.1 Public Meetings

Two rounds of public meetings in each of the watershed jurisdictions were a centerpiece of EPA's outreach efforts.

November–December 2009 Public Meetings

EPA and its jurisdiction partners sponsored 16 public meetings in the fall of 2009 to share information on the forthcoming Bay TMDL. A number of the public meetings were broadcast to a live, online audience via webinar. More than 2,000 people participated in the meetings, including 1,815 in person and 263 online via webinar at six of the locations. There was also a kickoff public meeting in Richmond, Virginia, in October 2009 that drew a combined live and online audience of more than 400 people.

The 2009 public meetings were held in

Martinsburg, West Virginia, November 4*

Moorefield, West Virginia, November 5

Washington, D.C., November 16*

Ashley, Pennsylvania, November 17

Williamsport, Pennsylvania, November 18

State College, Pennsylvania, November 19
Lancaster, Pennsylvania, November 23*
Binghamton, New York, December 1*
Baltimore, Maryland, December 8*
Laurel, Delaware, December 10*
Wye Mills, Maryland, December 11
Falls Church, Virginia, December 14
Chesapeake, Virginia, December 15
Williamsburg, Virginia, December 15
Penn Laird, Virginia, December 16
Fredericksburg, Virginia, December 17

* Meeting also was broadcast online via webinar. The largest live audiences were in Penn Laird, Virginia (205), and Lancaster, Pennsylvania (196).

September-November 2010 Public Meetings

The draft Chesapeake Bay TMDL was issued on September 24, 2010, commencing a 45-day public comment period. During that comment period, a total of 18 public meetings were held in all seven watershed jurisdictions. As in 2009, one of the meetings in each jurisdiction was broadcast online via webinar to a broader audience. The times, specific locations, directions, and parking information were posted on the Bay TMDL website:

<http://www.epa.gov/chesapeakebaytmdl>.

EPA and the respective jurisdictions each made presentations during the public meetings. Those presentations were posted on the Bay TMDL website as they happened. They can be found on the site as part of a summary of the 2010 public meetings.

Nearly 2,800 people participated in the meetings, including 2,311 in person (estimated based on sign-in sheets and headcounts) and 477 online via webinar.

The meetings and attendance figures were as follows:

Washington, D.C., September 29* (29 in person, 74 online)
Harrisonburg, Virginia, October 4 (330)
Annandale, Virginia, October 5 (135)
Richmond, Virginia, October 6 (250)
Webinar, October 7 (9 in person, 160 online)
Hampton, Virginia, October 7 (165)
Georgetown, Delaware, October 11* (90 in person, 16 online)
Easton, Maryland, October 12 (111)
Annapolis, Maryland, October 13 (200)
Hagerstown, Maryland, October 14* (60 in person, 65 online)
Lancaster, Pennsylvania, October 18 (200)
State College, Pennsylvania, October 19 (101)
Williamsport, Pennsylvania, October 20* (80 in person, 101 online)
Ashley, Pennsylvania, October 21 (40)
Elmira, New York, October 26 (120)
Binghamton, New York, October 27* (120 in person, 42 online)

Martinsburg, West Virginia, November 3 (100)

Romney, West Virginia, November 4* (171 in person, 19 online)

* Meeting also broadcast online via webinar. Webinar registration links were available on the Bay TMDL website listed above.

11.2.2 Webinars to Expand Audiences

EPA Region 3 was one of the first regional offices to acquire capacity to host large webinars. The system was obtained specifically to broadcast a representative number of the 2009 fall public meetings to online audiences, thus expanding the ability for the public to hear and participate in the meetings. Webinars were broadcast about monthly and were incorporated in a number of the fall 2010 public meetings—one in each jurisdiction.

Monthly Webinars

EPA sponsored monthly webinars in 2010 to keep the public up to date on Bay TMDL developments. The seven webinars drew a collective audience of 2,587 participants. The regularly scheduled webinars represent one of EPA’s Open Government flagship initiatives for public outreach. A substantial portion of each webinar was reserved for informal questions and answers.

The monthly webinars were advertised widely using stakeholder and jurisdiction lists of hundreds of people and organizations that have expressed an interest in the Bay TMDL. The registration links for the webinars were published prominently on the Bay TMDL website.

The monthly webinars were held on

February 25, 2010	TMDL Update 1	529 participants
March 25, 2010	TMDL Update 2	379 participants
May 17, 2010	TMDL Update 3	294 participants
June 7, 2010	TMDL Update 4	288 participants
July 8, 2010	TMDL Update 5	383 participants
August 9, 2010	TMDL Update 6	385 participants
September 28, 2010	TMDL Update 7	329 participants

Webinars Tailored to Specific Stakeholder Communities

In addition to the monthly webinars, EPA sponsored two webinars to review detailed modeling and other technical information with representatives of the agriculture and development communities.

The webinars were held on

March 22, 2010	Webinar for the Agriculture Community	218 participants
May 6, 2010	Webinar for the Development Community	84 participants

11.2.3 Chesapeake Bay TMDL Website

EPA established a website for the Chesapeake Bay TMDL in August 2009. The address is <http://www.epa.gov/chesapeakebaytmdl>.

The site continues to include the latest news and information on the Bay TMDL, along with fact sheets, questions and answers, presentations, and other features. The site has consistently been one of the most popular in EPA Region 3 according to access numbers.

In addition, the Chesapeake Bay Program partnership's website (www.chesapeakebay.net) has contained detailed information involving Bay TMDL proceedings, including scientific data, PowerPoint presentations, and other items used in the process.

11.2.4 Public Notices

Federal Register Notices

EPA has issued two notices in the *Federal Register* regarding the Chesapeake Bay TMDL to ensure that the public has full advance notification of major events. The notices include a September 17, 2009, announcement (USEPA 2009a) of the public meetings and a September 22, 2010 announcement (USEPA 2010c) of the public review and comment period. EPA issued a third notice to announce establishment of the final Chesapeake Bay TMDL.

Newspaper Notices

EPA has issued notices in regional and local newspapers regarding the Chesapeake Bay TMDL to ensure that the public throughout the watershed has full advance notification of major events.

11.3 Responses to Public Comments

The Draft Chesapeake Bay TMDL was available for public comment from September 24, 2010, to November 8, 2010. Comments were accepted electronically via Docket ID No. EPA-R03-OW-2010-0736 at www.regulations.gov, by mail, and by hand delivery. A link to review and comment on the Bay TMDL was provided through the Bay TMDL website.

EPA received more than 14,000 comments on the Bay TMDL, including more than 700 detailed comment letters. More than 90 percent of the comments, including many similar submissions, were in favor of the TMDL. Comments came from many different sources, including individual citizens, industry, local government, environmental organizations, and academia.

A team of EPA specialists reviewed and responded to all written comments submitted during the public comment period and the comments were considered, as appropriate, in the establishment of the final Bay TMDL. Responses to the comments are included in Appendix W in the final Bay TMDL document.

11.4 Interaction with States, D.C. on Watershed Implementation Plans

EPA provided considerable assistance to the six watershed states and the District of Columbia in the development of their draft and final WIPs. In addition to financial and technical assistance, EPA held numerous meetings and conference calls with each of the jurisdictions to provide input and guidance and to reiterate expectations for the WIPs. A listing of those conference calls and meetings are included in Appendix C in this document.

SECTION 12. REFERENCES

- Aber, J.D., K.J. Nadelhoffer, P. Steudler, and J.M. Melillo. 1989. Nitrogen saturation in northern forest ecosystems. *Bioscience* 39(6):378-386.
- American Canoe Association, Inc., et al. v U.S. Environmental Protection Agency, et al., Civil Action No. 98-979-A, (E.D. Va. June 11, 1999).
- American Littoral Society, et al. v EPA, et al., No. 96-330 (D. Del.).
- Batiuk, R.A., R. Orth, K. Moore, J.C. Stevenson, W. Dennison, L. Staver, V. Carter, N.B. Rybicki, R. Hickman, S. Kollar, and S. Bieber. 1992. *Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: A Technical Synthesis*. CBP/TRS 83/92. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- Batiuk, R.A., P. Bergstrom, M. Kemp, E. Koch, L. Murray, J.C. Stevenson, R. Bartleson, V. Carter, N.B. Rybicki, J.M. Landwehr, C. Gallegos, L. Karrh, M. Naylor, D. Wilcox, K., A. Moore, S. Ailstock, and M. Teichberg. 2000. *Chesapeake Bay Submerged Aquatic Vegetation Water Quality and Habitat-Based Requirements and Restoration Targets: A Second Technical Synthesis*. CBP/TRS 245/00 EPA 903-R-00-014. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- Batiuk, R.A., D.L. Breitburg, R.J. Diaz, T.M. Cronin, D.H. Secor, and G. Thursby. 2009. Derivation of habitat-specific dissolved oxygen criteria for Chesapeake Bay and its tidal tributaries. *Journal of Experimental Marine Biology and Ecology* 381:S204–S215.
- Bicknell, B.R., J.C. Imhoff, J.L. Kittle Jr., T.H. Jobes, and A.S. Donigian Jr. 2005. Hydrological Simulation Program—FORTRAN. User’s Manual for Release 12.2. U.S. Environmental Protection Agency Ecosystem Research Division, Athens, GA, and U.S. Geological Survey, Office of Surface Water, Reston, VA.
- Brakebill, J.W., S.W. Ator, and G.E. Schwarz. 2010. Sources of suspended-sediment flux in streams of the Chesapeake Bay Watershed: A Regional Application of the SPARROW Model. *JAWRA* 46(4):757–776.
- Brakebill, J.W., and S.D. Preston. 2007. Factors affecting the distribution and transport of nutrients. In *Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management* ed. Phillips. U.S. Geological Survey Circular 1316, 63p.
- Brakebill, J., and S. Preston. 2004. Digital Data Used to Relate Nutrient Inputs to Water Quality in the Chesapeake Bay Watershed, Version 3.0. USGS Open-File Report 2004-1433. U.S. Geological Survey, Reston, VA.
- Brown, K.W. and J.C. Thomas. 1978. Uptake of Nitrogen by Grass from Septic Fields in Three soils. *Agronomy Journal* 70(6):1037-1040.

- Buchanan, C., ed. 1993. Development of Zooplankton Community Environmental Indicators for Chesapeake Bay. ICPRB Report 93-2. Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD, and Maryland Department of the Environment, Baltimore, MD.
- Campbell, K.L. 1982. Nutrient transport from North Florida agricultural fields and watersheds. Ed. Baldwin, L. B.; Bottcher, A. B. IFAS Conference on Nonpoint Pollution Control Technology, Gainesville, FL.
- Carpenter, K., J.M. Johnson, and C. Buchanan. 2006. An index of biotic integrity based on the summer polyhaline zooplankton community of the Chesapeake Bay. *Marine Environmental Research* 62(3):165-180.
- Castro, M. S., K.N. Eshleman, R.P. Morgan II, S.W. Seagle, R.H. Gardner, and L.F. Pitelka. 1997. Nitrogen dynamics in forested watersheds of the Chesapeake Bay. STAC Report Number: 97-3. Edgewater, MD.
- Center for Watershed Protection. 2003. *Impacts of Impervious Cover on Aquatic Systems*. Center for Watershed Protection, Ellicott City, MD.
- Cerco, C., and T. Cole. 1993. Three-dimensional eutrophication model of Chesapeake Bay. *Journal of Environmental Engineering* 119(6):1006-1025.
- Cerco, C.F., and T. Cole. 1994. *Three-Dimensional Eutrophication Model of Chesapeake Bay*. Technical Report EL-94-4. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.
- Cerco, C. 2000. Phytoplankton kinetics in the Chesapeake Bay model. *Water Quality and Ecosystem Modeling* 1:5-49.
- Cerco, C., B. Johnson, and H. Wang. 2002. *Tributary refinements to the Chesapeake Bay model*. ERDC TR-02-4. U.S. Army Engineer Corps of Engineers Research and Development Center, Vicksburg, MS.
- Cerco, C.F. and M.R. Noel. 2004. *The 2002 Chesapeake Bay Eutrophication Model*. EPA 903-R-04-004. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Cerco, C., S.C. Kim, and M.R. Noel. 2010. The 2010 Chesapeake Bay Eutrophication Model. A Report to the US Environmental Protection Agency and to the US Army Corps of Engineer Baltimore District. US Army Engineer Research and Development Center, Vicksburg, MD.
- Chesapeake Bay Partnership. 1983. *The Chesapeake Bay Agreement of 1983*. Chesapeake Bay Partnership, Washington, DC.
- CBP (Chesapeake Bay Program). 1987. *Habitat Requirements for Chesapeake Bay Living Resources*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Chesapeake Bay Living Resources Task Force, Annapolis, MD.

- CBP (Chesapeake Bay Program). 1989a. *Chesapeake Bay Monitoring Program Atlas-Volume I: Water Quality and Other Physiochemical Monitoring Programs*. CBP/TRS 34/89. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- CBP (Chesapeake Bay Program). 1989b. *Chesapeake Bay Monitoring Program Atlas-Volume II: Biological and Living Resource Monitoring Programs*. CBP/TRS 35/89. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- CBP (Chesapeake Bay Program). 1997. *Chesapeake Bay Nutrient Reduction Progress and Future Directions—Nutrient Reevaluation Summary Report*. CBP/TRS 189/97. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- CBP (Chesapeake Bay Program). 1998. *Chesapeake Bay Watershed Model Application and Calculation of Nutrient and Sediment Loadings – Appendix F: Phase IV Chesapeake Bay Watershed Model Point Source Load*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Nutrient Subcommittee, Annapolis, MD.
- CBP (Chesapeake Bay Program). 1999. *Process for Integrating the Cooperative and Statutory Programs of the Chesapeake Bay and its Tributaries—Continuing the Watershed Partnership to Restore the Chesapeake Bay*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- CBP (Chesapeake Bay Program). 2004a. *Establishing a Chesapeake Bay Nontidal Watershed Water-Quality Network*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- CBP (Chesapeake Bay Program). 2004b. *Water Quality Database, Database Design and Data Dictionary*. January 2004. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- CBP (Chesapeake Bay Program). 2008. *Nontidal Water Quality Monitoring. November 2008. Chapter V of Recommended Guidelines for Sampling and Analysis in the Chesapeake Bay Monitoring Program, Revision 1-Draft*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, Maryland.
- CBP (Chesapeake Bay Program). 2009. *Chesapeake Bay Program Governance—Managing the Partnership for a Restored and Protected Watershed and Bay*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- CBP (Chesapeake Bay Program). 2010a. *Chesapeake Bay Nontidal Water-Quality Sampling Progress Report, Calendar Year 2009*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.
- CBP (Chesapeake Bay Program). 2010b. *Guide to Using the Chesapeake Bay Program Water Quality Monitoring Data*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

- CBP PSC (Chesapeake Bay Program Principals' Staff Committee). 2007. October 1, 2007 Meeting Summary of the Chesapeake Bay Program Principals' Staff Committee, Annapolis Friends Meeting House, Annapolis, MD.
- Chesapeake Bay Reevaluation Steering Committee. 2005. Chesapeake Bay Program 2007 Reevaluation Workshop, Lancaster, PA, September 21–22, 2005. Summary of Issues, Actions and Decisions. Chesapeake Bay Reevaluation Steering Committee, Annapolis, MD.
- Chesapeake Bay Watershed Partners. 2000. *Memorandum of Understanding among the State of Delaware, the District of Columbia, the State of Maryland, the State of New York, the Commonwealth of Pennsylvania, the Commonwealth of Virginia, the State of West Virginia, and the United States Environmental Protection Agency Regarding Cooperative Efforts for the Protection of the Chesapeake Bay and Its Rivers*. Chesapeake Bay Watershed Partners, Annapolis, MD.
- Chesapeake Bay Watershed Partners. 2004. *Memorandum of Understanding among the State of Delaware, the District of Columbia, the State of Maryland, the State of New York, the Commonwealth of Pennsylvania, the Commonwealth of Virginia, the State of West Virginia, the Interstate Commission on the Potomac River Basin, the Susquehanna River Basin Commission, the Metropolitan Washington Council of Governments, the United States Environmental Protection Agency, the United States Geological Survey and the Chesapeake Bay Commission regarding Cooperative Efforts for Monitoring and Assessing Water Quality in the Streams and Rivers of the Chesapeake Bay Watershed*. September 23, 2004. Chesapeake Bay Watershed Partners, Annapolis, MD.
- CEC (Chesapeake Executive Council). 1987. *Chesapeake Bay Agreement*. Chesapeake Bay Program, Annapolis, MD.
- CEC (Chesapeake Executive Council). 1992. *Chesapeake Bay Agreement—1992 Amendments*. Chesapeake Bay Program, Annapolis, MD.
- CEC (Chesapeake Executive Council). 1997. Directive No. 97-1 Basinwide Nutrient Reduction Progress and Future Direction. Chesapeake Bay Program, Annapolis, MD.
- CEC (Chesapeake Executive Council). 2000. Chesapeake 2000. Chesapeake Bay Program, Annapolis, MD.
- CEC (Chesapeake Executive Council). 2003. Directive No. 03-02 Meeting the Nutrient and Sediment Reduction Goals. Chesapeake Bay Program, Annapolis, MD.
- CEC (Chesapeake Executive Council). 2005. Directive No. 04-02 Meeting the Nutrient and Sediment Reduction Goals—Next Steps. Chesapeake Bay Program, Annapolis, MD.
- Claggett, P.R., and C. Bisland. 2004. Assessing the vulnerability of forests and farmlands to development in the Chesapeake Bay Watershed, in *Proceedings of the IASTED International Conference on Environmental Modeling and Simulation*, November 22–24, 2004, St. Thomas, U.S. Virgin Islands.

- Clark, G.M., D.K. Mueller, and M.A Mast. 2000. Nutrient concentrations and yields in undeveloped stream basins of the United States. *Journal of the American Water Resources Association* 36(4):849–860.
- Clarke, K.C., S. Hoppen , and L. Gaydos. 1997. A self-modifying cellular automaton model of historical urbanization in the San Francisco Bay area. *Environment and Planning B.- Planning and Design* 24:247–261.
- Curtin, P.D., G.S. Brush, and G.W. Fisher. 2001. *Discovering the Chesapeake*. Johns Hopkins University Press, Baltimore, MD.
- Dauer, D.M. and R.J. Llansó. 2003. Spatial scales and probability based sampling in determining levels of benthic community degradation in the Chesapeake Bay. *Environmental Monitoring and Assessment* 81:175-186.
- DC DOE (District of Columbia Department of the Environment). 2008. *Integrated Report*. District of Columbia Department of the Environment, Washington, DC.
- DC DOH (District of Columbia Department of Health). 1998 303(d) List. District of Columbia Department of Health, Washington, DC.
- DE DNREC (Delaware Department of Natural Resources and Environmental Control). 1996. *State of Delaware 1996 Clean Water Act Section 303(d) List of Waters*. Delaware Department of Natural Resources and Environmental Control, Dover, DE.
- DE DNREC (Delaware Department of Natural Resources and Environmental Control). 1998. *Total Maximum Daily Load (TMDL) Analysis for Nanticoke River and Broad Creek Delaware*. Delaware Department of Natural Resources and Environmental Control, Dover, DE.
- DE DNREC (Delaware Department of Natural Resources and Environmental Control). 2008. *State of Delaware 2008 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs*. Delaware Department of Natural Resources and Environmental Control, Dover, DE.
- Dennis, R., R. Haeuber, T. Blett., J. Cosby, C. Driscoll, J. Sickles, and J. Johnson. 2007. Sulfur and nitrogen deposition on ecosystems in the United States. *Journal of the Air and Waste Management Association*. December 2007.
- Dennison, W.C., R.J. Orth, K.A. Moore, J.C. Stevenson, V. Carter, S. Kollar, P.W. Bergstrom, and R.A. Batiuk. 1993. Assessing water quality with submersed aquatic vegetation habitat requirements as barometers of Chesapeake Bay health. *Bioscience* 43(2):86–94.
- Di Toro, D.M. 2001. *Sediment Flux Modeling*. Wiley-Interscience, New York, NY.
- Fennel, K., J. Wilkin, J. Levin, J. Moisan, J. O’Reilly, and D. Haidvogel. 2006. Nitrogen cycling in the Middle Atlantic Bight: Results from a three dimensional model for the North Atlantic nitrogen budget *Global Biogeochemical Cycles* 20(GB3007).

- FLCCB (Federal Leadership Committee for the Chesapeake Bay). 2010. *Strategy for Protecting and Restoring the Chesapeake Bay Watershed*. Pursuant to Executive Order 13508. Federal Leadership Committee for the Chesapeake Bay, Washington, DC.
- Funderburk, S.L., S.J. Jordan, J.A. Mihursky, and D.R. Riley (eds). 1991. *Habitat Requirements for Chesapeake Bay Living Resources, 1991 Second Edition*. Living Resources Subcommittee, Chesapeake Bay Program, Annapolis, MD.
- Gallegos, C.L. 2001. Calculating optical water quality targets to restore and protect submersed aquatic vegetation: overcoming problems in partitioning the diffuse attenuation coefficient for photosynthetically active radiation. *Estuaries* 24 (3):381–397.
- Gellis, A.C., C.R. Hupp, M.J. Pavich, J.M. Landwehr, W.S.L. Banks, B.E. Hubbard, M.J. Langland, J.C. Ritchie, and J.M. Reuter. 2009. *Sources, Transport, and Storage of Sediment at Selected Sites in the Chesapeake Bay Watershed*. Scientific Investigations Report 2008–5186. U.S. Geological Survey, Reston, VA.
- Goetz, S.J., C.A. Jantz, S.D. Prince., A.J. Smith, D. Varlyguin, and R. Wright. 2004. Integrated analysis of ecosystem interactions with land use change: The Chesapeake Bay watershed. In *Ecosystems and Land Use Change*, ed. R.S. DeFries, G.P. Asner, and R.A. Houghton, pp 263-275. American Geophysical Union, Geophysical Monograph Series, Washington, DC.
- Goetz, S.J., and C.A. Jantz. 2006. *Modeling the Rates and Spatial Patterns of Future Land Cover Change in the Chesapeake Bay Watershed*. CB-973009-01. Final Report to the Chesapeake Bay Program, Chesapeake Bay Program Assistance Agreement, Annapolis, MD.
- Goodale, C.L.; K. Lajtha, K.J. Nadelhoffer, E.W. Boyer, and N.A. Jaworski. 2002. Forest nitrogen sinks in large eastern U.S. watersheds: estimates from forest inventory and an ecosystem model. *Biogeochemistry* 57(58):39-266.
- Grimm, J.W., and J.A. Lynch. 2000. *Enhanced wet deposition estimates for the Chesapeake Bay watershed using modeled precipitation inputs*. CBWP-MANTA-AD-99-2. Maryland Department of Natural Resource Chesapeake Bay and Tidewater Programs, Annapolis, MD.
- Grimm, J.W., and J.A. Lynch. 2005. Improved daily precipitation nitrate and ammonium concentration models for the Chesapeake Bay Watershed. *Environmental Pollution* 135(2005):445–455.
- Hameedi, J., H. Paerl, M. Kennish, and D. Whitall. 2007. Nitrogen deposition in U.S. coastal bays and estuaries. *Journal of the Air and Waste Management Association*. December 2007.
- Horne, Alexander J., and C.R. Goldman. 1994. *Limnology*. Second edition. McGraw-Hill, Inc. Edited by Kathi M. Prancan and John M. Morriss.
- Howarth, R.W., G. Billen, D. Swaney, A. Townsend, N. Jaworski, K. Lajtha, J.A. Downing, E.R. Elmgren, N. Caraco, T. Jordan, F. Berendse, J. Freney, V. Kudeyarov, P. Murdoch, H. Zhao-liang, and H. Zhu. 1995. Regional nitrogen budgets and riverine N & P fluxes for the drainages to the North Atlantic Ocean: Natural and human influences. *Biogeochemistry* 35(1):75-139.

- Howarth, R.W. 1998. An assessment of human influences on fluxes of nitrogen from the terrestrial landscape to the estuaries and continental shelves of the North Atlantic Ocean. *Nutrient Cycling in Agroecosystems* 52:213-223.
- Huddleston, J.H., and M.P. Ronayne. 1990. *Guide to Soil Suitability and Site Selection for Beneficial Use of Sewage Sludge*. Manual 8. PB95-159596. Oregon State University Extension Service, Corvallis, and U.S. Environmental Protection Agency, Office of Water. Washington, DC.
- Irani, F.M. and P.R. Claggett. 2010. *Chesapeake Bay Watershed Land Cover Change Data Series: U.S. Geological Data Series 505*. U.S. Geological Survey, Reston, VA.
- Jantz, C.A., J.S. Goetz, and M.K. Shelley. Using the SLEUTH urban growth model to simulate the impacts of future policy scenarios on urban land use in the Baltimore–Washington metropolitan area. *Environment and Planning B.-Planning and Design* 31(2):251-271.
- Jordan, S.J., C. Stenger, M. Olson, R. Batiuk, and K. Mountford. 1992. *Chesapeake Bay dissolved oxygen goal for restoration of living resource habitats: A synthesis of living resource requirements with guidelines for their use in evaluating model results and monitoring information*. CBP/TRS 88/93. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Kemp, W.M., R.A. Batiuk, R. Bartleson, P. Bergstrom, V. Carter, C.L. Gallegos, W. Hunley, L. Karrh, E. Koch, J.M. Landwehr, K.A. Moore, L. Murray, M. Naylor, N.B. Rybicki, J.C. Stevenson, and D.J. Wilcox. 2004. Habitat requirements for submerged aquatic vegetation in Chesapeake Bay: Water quality, light regime and physical-chemical factors. *Estuaries* 27(3):363–377.
- Kemp, W.M., W.R. Boynton, J.E. Adolf, D.F. Boesch, W.C. Boicourt, G. Brush, J.C. Cornwell, T.R. Fisher, P.M. Glibert, J.D. Hagy, L.W. Harding, E.D. Houde, D.G. Kimmel, W.D. Miller, R.I.E. Newell, M.R. Roman, E.M. Smith, and J.C. Stevenson. 2005. Eutrophication of Chesapeake Bay: Historical trends and ecological interactions. *Marine Ecology Progress Series* 303:1–29.
- Kingman Park Civic Association, et al. v. U.S. Environmental Protection Agency, et al., Case No. 98CV00758 (D.D.C. June 13, 2000).
- Lacouture, R.V., C. Buchanan, J.M. Johnson, and H.G. Marshall. 2006. Phytoplankton index of biotic integrity for Chesapeake Bay and its tidal tributaries. *Estuaries and Coast* 29(4):598-616.
- Lane, M. 2004. *CIMS Data Upload and Quality Assurance Tool: Data User's Guide*. August 2002. Prepared for Region 3 Chesapeake Bay Program Office, Annapolis, MD, by Veridyne, Inc., Broomall, PA.
- Langland, M.J., P.I. Lietman, and S. Hoffman. 1995. Synthesis of Nutrient and Sediment Data for Watersheds within the Chesapeake Bay Drainage Basin: USGS in cooperation with EPA Water Resources Investigations Report 95-4233. Lemoyne, PA.

- Langland, M., and T. Cronin, 2003. *A Summary Report of Sediment Processes in Chesapeake Bay and Watershed*. USGS Water-Resources Investigations Report 03-4123. U.S. Geological Survey, New Cumberland, PA.
- Leopold, L.B.; M.G. Wolman, and J.P. Miller. 1995. *Fluvial Processes in Geomorphology*. Dover Publications. ISBN 0-486-68588-8.
- Linker, L.C. 2003. *A Comparison of Estimated Water Quality Effects of Monthly and Annual Based Load Point Source Load Reductions*. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Linker, L.C. 2005. *Labile and Refractory Organic Nitrogen in Chesapeake Bay Wastewater Treatment Plants: Measurement and Model Simulation*. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Linker, L.C., G.W. Shenk, P. Wang, C. Cerco, A. Butt, P. Tango, and R. Savage. 2002. *A Comparison of Chesapeake Bay Estuary Model Calibration with 1985–1994 Observed Data and Method of Application to Water Quality Criteria*. Chesapeake Bay Program Modeling Subcommittee Report. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Linker, L.C., T. Johnson, J. Kittle Jr., G.W. Shenk. 2007. *Evaluating 2030 Climate Change in the Chesapeake Watershed*. American Water Research Association Annual Conference, November 12-15, 2007, Albuquerque, NM.
- Linker, L.C., G.W. Shenk, P. Wang, and R. Batiuk, 2008. Chapter 3: Integration of Modeling, Research, and Monitoring in the Chesapeake Bay Program. In *Management of Water Quality and Irrigation Techniques*, ed. J.Albiac and A. Dinar. Earthscan. London, U.K.
- Llansó, R.J., D.M. Dauer, J.H. Vølstad, and L.S. Scott. 2003. Application of the benthic index of biotic integrity to environmental monitoring in Chesapeake Bay. *Environmental Monitoring and Assessment* 81:163-174.
- Lynch, J.A., and J.W. Grimm. 2003. *Improved Daily Nitrate and Ammonium Concentration Models for the Chesapeake Bay Watershed*. Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Maizel, M., G. Muehlbach, P. Baynham, J. Zoerker, D. Monds, T. Iivari, P Welle, J. Robbin, and J. Wiles. 1995. *The Potential for Nutrient Loadings from Septic Systems to Ground and Surface Water Resources and the Chesapeake Bay*. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Marshall, H.G., R. Lacouture, C. Buchanan, and J. Johnson. 2006. Phytoplankton assemblages associated with water quality and salinity in Chesapeake Bay, U.S.A. *Estuarine, Coastal, and Shelf Science* 69:10–18.

- Martucci, S.K., J.L. Krstolic, J.P. Raffensperger, and K.J. Hopkins. 2006. *Development of Land Segmentation, Stream-Reach Network, and Watersheds in Support of Hydrologic Simulation Program-Fortran (HSPF) Modeling, Chesapeake Bay Watershed, and Adjacent Parts of Maryland, Delaware, and Virginia*. U.S. Geological Survey, Reston, VA.
- MD DNR (Maryland Department of Natural Resources). 2009. *Quality Assurance Project Plan for the Maryland DNR Chesapeake Bay Shallow Water Monitoring Program for the period July 1, 2009—June 30, 2010*. Maryland Department of Natural Resources, Annapolis, MD.
- MDE (Maryland Department of the Environment). 1998, as amended 2004. Memorandum of Understanding between the State of Maryland and the United States Environmental Protection Agency, Region 3, regarding Sections 303(d) and 303(e) of the Clean Water Act. Maryland Department of the Environment, Baltimore, MD.
- MDE (Maryland Department of the Environment). 2000. TMDL of Biochemical Oxygen Demand (BOD) for the Western Branch of the Patuxent River, Prince George's County, MD (Approved on June 6, 2000). Maryland Department of the Environment, Baltimore, MD.
- MDE (Maryland Department of the Environment). 2004. September 2, 2004, Letter Revising Memorandum of Understanding between the State of Maryland and the United States Environmental Protection Agency, Region 3. Maryland Department of the Environment, Baltimore, MD.
- MDE (Maryland Department of the Environment). 2008. *Integrated List*. Maryland Department of the Environment, Baltimore, MD.
- MDE and DC DOE (Maryland Department of the Environment and District of Columbia Department of the Environment). 2008. Total Maximum Daily Loads of Nutrients/Biochemical Oxygen Demand for the Anacostia River Basin, Montgomery and Prince George's Counties, Maryland and the District of Columbia. EPA approved June 5, 2008.
- MD OEP (Maryland Office of Environmental Protection). 1987. *Monitoring for Management Actions: Chesapeake Bay Water Quality Monitoring Program—First Biennial Report*. Maryland Department of the Environment, Baltimore, MD.
- MRAT (Monitoring Re-Alignment Action Team). 2009. *Monitoring Re-Alignment Action Team: Final Report to the CBP Management Board*. October 27, 2009. Chesapeake Bay Program, Annapolis, Maryland.
- Nixon, S.W. 1997. Prehistoric nutrient inputs and productivity in Narragansett Bay. *Estuaries* 20(2):253-261.
- NMFS (National Marine Fisheries Service). 2003. *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries. National Marine Fisheries Service Endangered Species Act Biological Opinion*. F/NER/2003/00961. Northeast Region, Gloucester, MA.

- Officer, C.B., R.B. Biggs, J.L. Taft, L.E. Cronin, M.A. Tyler, and W.R. Boynton. 1984. Chesapeake Bay Anoxia: Origin, development and significance. *Science* 223(4631):22-27.
- Orth, R.J., and K.A. Moore. 1983. Chesapeake Bay: An unprecedented decline in submerged aquatic vegetation. *Science* 222(4619):51–53.
- Orth, R.J., D.J. Wilcox, J.R. Whiting, L.S. Nagey, A. Owens, and A. Kenne. 2010a. 2009 *Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Coastal Bays*. VIMS Special Scientific Report Number 152. Grant No. CB97377401-0. Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- Orth, R.J., M.R. Williams, S.R. Marion, D.J. Wilcox, T.J.B. Carruthers, K.A. Moore, W.M. Kemp, W.C. Dennison, N. Rybicki, P. Bergstrom, and R.A. Batiuk. 2010b. Long-Term Trends in Submersed Aquatic Vegetation (SAV) in Chesapeake Bay, USA, Related to Water Quality. *Estuaries and Coasts* 33:1144–1163.
- Palace, M., J. Hannawald, L. Linker, G. Shenk, J. Storricks, and M. Clipper. 1998. Appendix H: tracking best management practice nutrient reductions in the Chesapeake Bay Program. In: *Chesapeake Bay Watershed Model application and calculation of nutrient and sediment loadings*. EPA 903-R-98-009, CBP/TRS 201/98. Chesapeake Bay Program Office, Annapolis, MD.
- Pan, Y., R. Birdsey, J. Hom, and K. McCullough. 2005. *Forest Productivity and Effects of Nitrogen Deposition on Water Quality*. USDA Forest Service, Northwestern Area, Global Change Research.
- Preston, S.D., R.B. Alexander, M.D. Woodside, and P.A. Hamilton 2009. SPARROW MODELING—Enhancing Understanding of the Nation’s Water Quality. Fact Sheet 2009–3019. U.S. Geological Survey Reston, VA.
- Preston, S.D., and J.W. Brakebill. 1999. *Application of spatially referenced regression modeling for the evaluation of total nitrogen in the Chesapeake Bay watershed*. U.S. Geological Survey Water-Resources Investigations Report 99-4054, Baltimore, MD.
- Reilly, J. 2003. The New Jersey (USA) Growth Allocation Model: Development, evaluation and extension. In *Planning Support Systems in Practice, Advances in Spatial Science Series*, ed. S. Geertman and J. Stillwell, pp.373-389. Springer, Berlin.
- Riekerk, H., D.G. Neary, and W.T. Swank. 1988. The magnitude of upland silviculture nonpoint source pollution in the South. In *Conference on the Forested Wetlands of the Southern United States, Asheville, NC*, ed. D.D. Hook and L. Russ, pp: 8-18. U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station.
- Ritter, W.F., and A.E.M Chirside. 1984. Impact of land use on groundwater quality in Southern Delaware. *Groundwater* 22(1):38–47.
- Robertson, W.D., J.A. Cherry, and E.A. Suclicky. 1991. Ground-water contamination from two small septic systems on sand aquifers. *Groundwater* 29:82–92.

- Robertson, W.D., and J.A.Cherry. 1992. Hydrogeology of an unconfined sand aquifer and its effect on the behaviour of nitrogen from a large-flux septic system. *Applied Hydrogeology* 1:32-44.
- Rountree, H., W. Clark, and K. Mountford. 2007. *John Smith's Chesapeake Voyages 1607-1609*. University of Virginia Press, Charlottesville, VA.
- Salvato, J.A. 1982. *Environmental Engineering and Sanitation*. 3rd ed. Wiley-Interscience, New York, NY.
- Sawyer, C.N., P.L. McCarty, and G.F. Parkin. 1994. *Chemistry for Environmental Engineering*, 4th ed. McGraw-Hill, Inc. edited by B.J. Clark and John M. Morriss.
- Secretary Robert Perciasepe. 1992. Nutrient Reevaluation Load Allocations. October 14, 1992, Memorandum to the Principals' Staff Committee Members. Maryland Department of the Environment, Baltimore, MD.
- Secretary Tayloe Murphy. 2003. Summary of Decisions Regarding Nutrient and Sediment Load Allocations and New Submerged Aquatic Vegetation (SAV) Restoration Goals. April 25, 2003, Memorandum to the Principals' Staff Committee members and representatives of the Chesapeake Bay headwater states. Virginia Office of the Governor, Natural Resources Secretariat, Richmond, VA.
- Smith, D.E., M. Leffler, and G. Mackiernan, eds. 1992. *Oxygen Dynamics in the Chesapeake Bay: A Synthesis of Recent Research*. Maryland and Virginia Sea Grant College Program, College Park, MD.
- STAC (Scientific and Technical Advisory Committee). 2005a. *Assessing Progress and Effectiveness through Monitoring Rivers and Streams*. Report to the Task Force on Analysis of Non-tidal Water Quality Modeling Results. STAC Publication 05-005. Chesapeake Bay Program Scientific and Technical Advisory Committee. Chesapeake Research Consortium, Edgewater, MD.
- STAC (Scientific and Technical Advisory Committee). 2005b. *Recommendations for Refinement of a Spatially Representative Non-tidal Water Quality Monitoring Network for the Chesapeake Bay Watershed*. Report to the Task Force on Non-tidal Water Quality Monitoring Network Design. STAC Publication 05-006. Chesapeake Bay Program Scientific and Technical Advisory Committee. Chesapeake Research Consortium, Edgewater, MD.
- STAC (Scientific and Technical Advisory Committee). 2006. *The Cumulative Frequency Diagram Method for Determining Water Quality Attainment: Report of the Chesapeake Bay Program STAC Panel to Review Chesapeake Bay Analytical Tools*. STAC Publication 06-003. Chesapeake Bay Program Scientific and Technical Advisory Committee. Chesapeake Research Consortium, Edgewater, MD.

- STAC (Scientific and Technical Advisory Committee). 2009. *Application of reference curves in dissolved oxygen criteria assessment. STAC Review and Recommendations for the Chesapeake Bay Program*. STAC Publication 09-005. Chesapeake Bay Program Scientific and Technical Advisory Committee. Chesapeake Research Consortium, Edgewater, MD.
- Stevenson, J.C., R. Brinsfield, and K. Staver. 1987. Surface runoff and groundwater impacts from agricultural activities in the Chesapeake region. In *Proceedings of the U.S. Committee on Irrigation and Drainage, Regional Meeting*, Washington, DC, ed. L. Stevens,.
- Stoddard, J.L., ed. 1994. Long-term changes in watershed retention of nitrogen: Its causes and aquatic consequences. In *Environmental Chemistry of Lakes and Reservoirs*, ed. L.A. Baker, ACS Advances in Chemistry Series No. 237. American Chemical Society, Washington, DC.
- Tetra Tech, Inc. 1999. *Improving Point Source Loadings Data for Reporting National Water Quality Indicators, Final Report*. Prepared for U.S. Environmental Protection Agency, Office of Wastewater Management (Contract #68-C-0014, Work Assignment 1-31), by Tetra Tech, Inc., Fairfax, VA.
- Trimble, S.W. 1999. Decreased rates of alluvial storage in the Coon Creek Basin, Wisconsin, 1975–1993. *Science* 285:1244–1246.
- USEPA (U.S. Environmental Protection Agency). 1982. *Chesapeake Bay Program Technical Studies: A Synthesis*. U.S. Environmental Protection Agency, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 1983a. *Chesapeake Bay: A Framework for Action*. U.S. Environmental Protection Agency, Philadelphia, PA.
- USEPA (U.S. Environmental Protection Agency). 1983b. *Chesapeake Bay: A Framework for Action—Appendices*. U.S. Environmental Protection Agency, Philadelphia, PA.
- USEPA (U.S. Environmental Protection Agency). 1983c. *Chesapeake Bay: A Profile of Environmental Change*. U.S. Environmental Protection Agency, Philadelphia, PA.
- USEPA (U.S. Environmental Protection Agency). 1983d. *Chesapeake Bay Program: Findings and Recommendations*. U.S. Environmental Protection Agency, Philadelphia, PA.
- USEPA (U.S. Environmental Protection Agency). 1991a. *Chesapeake Bay Coordinated Split Sample Program Implementation Guidelines*. CBP/TRS 58/91. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 1991b. *Guidance for Water Quality-Based Decisions: The TMDL Process*. EPA 440/4-91-001. U.S. Environmental Protection Agency, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 1996. *Recommended Guidelines for Sampling and Analysis in the Chesapeake Bay Monitoring Program*. August 1996. EPA 903-R-96-006. CBP/TRS 148/96. Region 3 Chesapeake Bay Program Office, Annapolis, MD.

- USEPA (U.S. Environmental Protection Agency). 1999. *Draft Guidance for Water Quality-Based Decisions: The TMDL Process. (Second Edition)*. EPA 844-D-99-001. U.S. Environmental Protection Agency, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2000. *Users Guide to Chesapeake Bay Program Biological and Living Resources Monitoring Data*. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2002a. *Establishing Total Maximum Daily Loads (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs*. November 22, 2002. U.S. Environmental Protection Agency Office of Water, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2002b. *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity, of Information Disseminated by the Environmental Protection Agency*. DOC EPA/260R-02-008. U.S. Environmental Protection Agency Office of Environmental Information, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2003a. *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. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2003b. *Biological Evaluation for the Issuance of Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries*. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2003c. *Setting and Allocating the Chesapeake Bay Basin Nutrient and Sediment Loads, the Collaborative Process, Technical Tools and Innovative Approaches*. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2003d. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability*. EPA 903-R-03-004. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2003e. *Water Quality Trading Policy*. January 13, 2003. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2004a. *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. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.

- USEPA (U.S. Environmental Protection Agency). 2004b. *Chesapeake Bay Program Analytical Segmentation Scheme: Revisions, Decisions and Rationales 1983–2003*. EPA 903-R-04-008. CBP/TRS 268/04. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2004c. Memorandum from James Hanlon to Jon Capacasa, March 3, 2004. Annual Permit Limits for Nitrogen and Phosphorus for Permits Designed to Protect Chesapeake Bay and its Tidal Tributaries from Excess Nutrient Loading under the National Pollutant Discharge Elimination System. U.S. Environmental Protection Agency, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2004d. *NPDES Permitting Approach for Discharges of Nutrients in the Chesapeake Bay Watershed—December 2004*. U.S. Environmental Protection Agency, Region 3, Philadelphia, PA.
- USEPA (U.S. Environmental Protection Agency). 2004e. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability—2004 Addendum*. EPA 903-R-04-006. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2005. *Chesapeake Bay Program Analytical Segmentation Scheme: Revisions, Decisions and Rationales 1983-2003. 2005 Addendum*. EPA 903-R-05-004. CBP/TRS 278-06. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2006. *Establishing TMDL “Daily” Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No.05-5015, (April 25, 2006) and Implications for NPDES permits*. Memorandum from Benjamin Grumbles, Assistant Administrator, Office of Water. U.S. Environmental Protection Agency, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2007a. *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. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2007b. *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. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2007c. *Options for the Expressing Daily Loads in TMDLs*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds. Washington, DC.

- USEPA (U.S. Environmental Protection Agency). 2007d. *Water Quality Trading Toolkit for Permit Writers*. 833-R-07-004. U.S. Environmental Protection Agency, Office of Wastewater Management, Water Permits Division, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2008a. *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. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2008b. September 11, 2008, Letter from Region 3 Administrator Donald Welsh to Secretary John Griffin, Maryland Department of the Environment.
- USEPA (U.S. Environmental Protection Agency). 2009a. Clean Water Act Section 303(d): Preliminary Notice of Total Maximum Daily Load (TMDL) Development for the Chesapeake Bay. U.S. Environmental Protection Agency, Region 3, Water Protection Division. *Federal Register*. September 17, 2009, 74:47794.
- USEPA (U.S. Environmental Protection Agency). 2009b. Letter from Region 3, Acting Administrator William C. Early to Secretary L. Preston Bryant, Virginia Department of Natural Resources, November 3, 2009.
- USEPA (U.S. Environmental Protection Agency). 2009c. Letter from Region 3, Acting Administrator William C. Early to Secretary L. Preston Bryant, Virginia Department of Natural Resources, November 4, 2009.
- USEPA (U.S. Environmental Protection Agency). 2009d. Letter from Region 3 Administrator Shawn M. Garvin to Secretary L. Preston Bryant, Virginia Department of Natural Resources, December 29, 2009.
- USEPA (U.S. Environmental Protection Agency). 2010a. *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*. May 2010. EPA 903-R-10-002. CBP/TRS 301-10. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2010b. *Chesapeake Bay Program Grant and Cooperative Guidance*. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2010c. Clean Water Act Section 303(d): Notice for the public review of the Draft Total Maximum Daily Load (TMDL) for the Chesapeake Bay. U.S. Environmental Protection Agency, Region 3, Water Protection Division. *Federal Register*. September 22, 2010, 75: 57776-57778.

- USEPA (U.S. Environmental Protection Agency). 2010d. *Estimates of County Level Nitrogen and Phosphorus Data for Use in Modeling Pollutant Reductions. December 2010*. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2010e. *Guide for EPA's Evaluation of Phase I Watershed Implementation Plans*. U.S. Environmental Protection Agency, Region 3, Philadelphia, PA.
- USEPA (U.S. Environmental Protection Agency). 2010f. Letter from Region 3 Administrator Shawn M. Garvin to the Chesapeake Bay Program Principals' Staff Committee Members, June 11, 2010.
- USEPA (U.S. Environmental Protection Agency). 2010g. Letter from Region 3 Administrator Shawn M. Garvin to the Chesapeake Bay Program Principals' Staff Committee Members, July 1, 2010.
- USEPA (U.S. Environmental Protection Agency). 2010h. Letter from Region 3 Administrator Shawn M. Garvin to the Chesapeake Bay Program Principals' Staff Committee Members, August 13, 2010.
- USEPA (U.S. Environmental Protection Agency). 2010i. *Our Nation's Air: Status and Trends Through 2008*. EPA-454/R-09-002. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- USEPA (U.S. Environmental Protection Agency). 2010j. *Phase 5.3 Chesapeake Bay Watershed Model Documentation*. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- USEPA (U.S. Environmental Protection Agency). 2010k. *Quality Management Plan for the Chesapeake Bay Program Office. September 2010*. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.
- VADEQ (Virginia Department of Environmental Quality). 2004. *James River Alternatives Analysis. Addendum #4*. Virginia Department of Environmental Quality, Richmond, VA.
- VADEQ (Virginia Department of Environmental Quality). 1998. 303(d) List. Virginia Department of Environmental Quality, Richmond, VA.
- VADEQ (Virginia Department of Environmental Quality). 2008. Integrated Report. Virginia Department of Environmental Quality, Richmond, VA.
- VIMS (Virginia Institute of Marine Science). 2009. *Quality Assurance Project Plan for the Rappahannock, Corrotoman and York Rivers & Potomac River Virginia Embayment Shallow Water Monitoring (for the Period: January 1, 2009 through December 31, 2009)*. Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD, by Virginia Institute of Marine Science, Gloucester Point, VA.

- VIMS (Virginia Institute of Marine Science). 2010. *Quality Assurance Project Plan for the 2010 Submerged Aquatic Vegetation Distribution and Abundance Survey of Chesapeake Bay, Its Tributaries, and the Delmarva Coastal Bays*. Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD, by Virginia Institute of Marine Science, Gloucester Point, VA.
- Walter, R.C., and D.J. Merritts, 2008. Natural Streams and the Legacy of Water-Powered Mills. *Science* 319(5861):299–304.
- Wang, P., and L.C. Linker. 2009. Assessment of Nitrogen and Phosphorus Control Trade-Offs Using a Water Quality Model with a Response Surface Method. *Journal of Water Resources Planning and Management* 135(3):171–177.
- Wang, P., L.C. Linker, R.A. Batiuk, and C.F. Cerco. 2006. Surface Analysis of Chesapeake Bay Water Quality Response to Different Nutrient and Sediment Loads. *Journal of Environmental Engineering* 132(3):377–383.
- Weisberg, S.B., J.A. Ranasinghe, D.M. Dauer, L.C. Schaffner, R.J. Diaz, and J.B. Frithsen. 1997. An estuarine benthic index of biotic integrity (B-IBI) for Chesapeake Bay. *Estuaries* 20(1):149–158.

SECTION 13. GLOSSARY

Airshed. A geographic area delineating the relative location of air emission sources contributing to the atmospheric deposition to a down-wind watershed.

Allocations. Best estimates of current and future pollutant loads (both nonpoint and point sources) entering a water body. Pollutant load estimates can range from reasonably accurate measurements to gross estimates and the techniques used for predicting specific loads.

Ammonia. An inorganic nitrogen compound. In water, ammonia levels in excess of the recommended limits may harm aquatic life.

Assimilative Capacity. The capacity of a natural body of water to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who consume the water.

Bay Segment. Subunits of the Chesapeake Bay estuary that were derived on the basis of specific selection criteria related to factors such as jurisdictional boundaries and other water quality, physical, geographic, and habitat related characteristics. The Chesapeake Bay and its tidal tributaries and embayments are divided into 92 segments.

Best Management Practices. Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

Bloom. A proliferation of algae or higher aquatic plants (or both) in a body of water; often related to pollution, especially when pollutants accelerate growth. Blooms are often the result of excessive levels of nutrients—generally nitrogen and phosphorus—in water.

Boundary Conditions. The definition or statement of conditions or phenomena at the boundaries of a model; water levels, flows, and concentrations that are specified at the boundaries of the area being modeled.

Chlorophyll *a*. A photosynthetic pigment that is found in green plants. The concentration of chlorophyll *a* is used as an indicator of water quality.

Critical Condition. Critical conditions are represented by the combination of loading, waterbody conditions, and other environmental conditions that result in impairment and violation of water quality standards. Critical conditions for an individual TMDL typically depend on applicable water quality standards, characteristics of the observed impairments, source type and behavior, pollutant, and waterbody type.

Critical Period. A period during which hydrologic, temperature, environmental, flow, and other such environmental conditions result in a waterbody being most sensitive to an identified impairment (e.g., summer low flow, winter high flow).

Delist. To remove an impaired waterbody from the Section 303(d) Impaired Waters List.

Delivered Load. The amount of a pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point of discharge/runoff after accounting for permanent reductions in pollutant loads due to natural in-stream processes in nontidal rivers.

Edge-of-Stream Load. The amount of a pollutant reaching a simulated stream segment from a point in that stream's watershed.

Effluent. Wastewater, either treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes or waters containing pollutants discharged into surface waters.

Eutrophication. The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Existing Flow. The average flow volume discharged from a facility based on monitored data.

Facility Design Flow. The maximum flow volume for which a facility is designed and permitted to operate at.

Failing Septic System. Septic systems in which the drain field has failed such that effluent that is supposed to percolate into the soil, rises to the surface and pools on the surface where it can run into streams or rivers.

Impaired Waters. Waters with chronic or recurring monitored violations of the applicable numeric or narrative water quality standards.

Load Allocation. The portion of the TMDL allocated to existing or future nonpoint sources and natural background.

Loading Capacity. The greatest pollutant loading a waterbody can receive without exceeding water quality standards.

Mainstem Bay. The Chesapeake Bay, from Havre de Grace, Maryland to the Virginia Capes, without the tidal tributaries and embayments included.

Margin of Safety. An accounting of uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of loading capacity.

Mesohaline. Salinity regime with >5-18 parts per thousand salinity.

Mixing Zone. A limited area or volume of a receiving water body where the initial dilution occurs and a permitted or authorized discharge occurs. Mixing zones are supposed to dilute or reduce pollutant concentrations below applicable water quality standards such that the applicable criteria in the standards are met at the edge of the mixing zone.

Model. A system of mathematical expressions that describe and represent the physical world or some aspect therein. In the Bay TMDL, models are used to describe both hydrologic and water quality processes as well as estimate the load of a specific pollutant to a water body and make predictions about how the load would change as remediation methods (e.g. scenarios) are implemented.

National Pollutant Discharge Elimination System (NPDES) permit program is authorized by the Clean Water Act and works to control water pollution by regulating point sources that discharge pollutants into waters of the United States. Industrial, municipal, and other facilities must obtain permits for any discharge into waters of the United States. In most cases, the NPDES permit program is administered by authorized states or EPA.

Nonpoint Source. Any source of water pollution that does not meet the legal definition of *point source*. Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification.

Nonsignificant Discharge Facility. A municipal or industrial wastewater discharge facility that is not defined as a *significant discharge facility* by the jurisdiction in which it is permitted. In general but not always, nonsignificant municipal facilities have design flows less than 0.4 million gallons per day (Virginia and Maryland thresholds are slightly different). Nonsignificant industrial facilities discharge less than 3,800 pounds per year total phosphorus and less than 27,000 pounds per year total nitrogen.

Oligohaline. Salinity regime with >0.5-5 parts per thousand salinity.

Point Source. Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft from which pollutants are or may be discharged.

Pollutant Source Sector. Category of related sources of nutrient and sediment loads identified for purposes of quantifying load allocations. Examples include agriculture, wastewater, forest, urban runoff.

Polyhaline. Salinity regime with 0-0.5 parts per thousand salinity.

Pycnocline. The depth in the water column where there is an abrupt change in density, temperature, and salinity. A pycnocline often forms in the Chesapeake Bay and its tidal tributaries when the lighter, warmer, and fresher water coming downstream from the spring rains overlays the denser, colder, and saltier water of the salt wedge bringing water upstream from the ocean.

Residence Time. Length of time that a pollutant remains with a section of a stream or river. Residence time is determined by streamflow and volume of the body in question.

Riparian. Referring to the areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Runoff. That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waters.

Section 303(d). A section of the Clean Water Act that requires periodic identification of waters that do not or are not expected to meet applicable water quality standards and the establishment of TMDLs for such waters.

Sediment. Soil, sand, and minerals washed from the land into water, usually after rain or snow melt.

Segment Watershed. Watershed area draining into one of the 92 Chesapeake Bay segments.

Significant Discharge Facility. A municipal or industrial wastewater facility defined as such by the jurisdiction in which it is permitted. Significant facilities are distinguished from nonsignificant facilities on the basis of flow for municipals and loads for industrials. In general but not always, significant municipal facilities have flows larger than 0.4 million gallons per day, and significant industrial facilities discharge loads larger than 3,800 pounds per year of total phosphorus and 27,000 pounds per year of total nitrogen.

Simulation Period. A period used to run the model scenario simulation, selected to ensure that the simulated rainfall, meteorological, and environmental time series used to drive the watershed simulation such that it accurately simulates the critical conditions.

Suspended Solids. Small particles of solid pollutants that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

Tidal Fresh. Salinity regime with 0-0.5 parts per thousand salinity.

Total Maximum Daily Load. Specifies the maximum amount of a pollutant that a waterbody can receive and still meet applicable water quality standards. It is the sum of the allocations for point sources (called wasteloads) and allocations for nonpoint sources (called loads) and natural background with a margin of safety (CWA section 303(d)(1)(c)). The TMDL can be described by the following equation:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Turbidity. A measure of the cloudy condition in water due to suspended solids or organic matter.

Wasteload Allocation. The portion of the TMDL allocated to existing, potential or future point sources.

Water Clarity Acre. An acre of shallow-water bay grass designated-use bottom habitat, located anywhere between the 2-meter depth contour and the adjacent shoreline inclusively, which has been observed to achieve the applicable salinity-regime-specific water clarity criteria.

Watershed. An area of land from which all water drains to a common point.

SECTION 14. ABBREVIATIONS

µg/L	microgram per liter
ADM	annual/daily maximum ratio
AEU	animal equivalent units
AFO	animal feeding operation
ASMFC	Atlantic States Marine Fisheries Commission
BART	best available retrofit technology
BayTAS	Chesapeake Bay TMDL Tracking and Accountability System
BMP	best management practice
BOD	biological oxygen demand
CAA	Clean Air Act
CAC	Citizen's Advisory Committee
CAFO	concentrated animal feeding operation
CAMR	Clean Air Mercury Rule
CBLCD	Chesapeake Bay land cover data
CBP	Chesapeake Bay Program
CEC	Chesapeake Executive Council
CFD	cumulative frequency distribution
CFR	<i>Code of Federal Regulations</i>
CIMS	Chesapeake Information Management System
CMAQ	Community Multi-scale Air Quality model
COE	U.S. Army Corps of Engineers
COMAR	Code of Maryland
CONMON	continuous monitoring
CSO	combined sewer overflow
CSS	combined sewer system
CWA	Clean Water Act
DAITS	Data and Information Tracking System
DC	District of Columbia
DC WASA	District of Columbia Water and Sewer Authority
DE	Delaware
DE DNREC	Delaware Department of Natural Resources and Environmental Control
DMR	discharge monitoring report
DO	dissolved oxygen
DUQAT	Data Upload and Quality Assurance Tool
E3	everything by everyone everywhere
EGU	electric generating unit
EISA	Energy Independence and Security Act
ELG	effluent limit guidelines
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FFIP	federal facility implementation plan
FR	<i>Federal Register</i>
GIS	geographic information system
ICIS	Integrated Compliance Information System

Kd	light attenuation coefficient
LA	load allocation
lbs	pounds
LC	loading capacity
LGAC	Local Governments Advisory Committee
Ln	natural log
LOESS	locally weighted scatter plot smoother
LTCP	Long-Term Control Plan
m	meter
MAWP	Mid-Atlantic Water Program
MD	Maryland
MDE	Maryland Department of the Environment
mgd	million gallons per day
mg/L	milligrams per liter
MOS	margin of safety
MOU	memorandum of understanding
MRAT	Monitoring Realignment Action Team
MS4	Municipal Separate Storm Sewer System
NADP	National Atmospheric Deposition Program
NAS	National Agricultural Statistics
NEIEN	National Environmental Information Exchange Network
NH ₃	ammonia
NH ₄ ⁺	ammonium
NMFS	National Marine Fisheries Service
NMP	nutrient management plan
NO ₂	nitrite
NO ₃	nitrate
NOI	notice of intent
NO _x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NY	New York
OSWTS	on-site wastewater treatment system
PA	Pennsylvania
PA DEP	Pennsylvania Department of Environmental Protection
PAR	photosynthetically active radiation
PCS	Permit Compliance System
PLW	percent light through water
POTW	publicly owned treatment works
PSC	Principals' Staff Committee
ppt	parts per thousand (salinity)
QA	quality assurance
QA/QC	quality assurance/quality control
RDA	Residual Designation Authority
RESAC	University of Maryland's Regional Earth Science Applications Center

SAV	submerged aquatic vegetation
SCR	selective catalytic reduction
SIP	state implementation plan
SNCR	selective non-catalytic reduction
SPARROW	Spatially Referenced Regressions on Watershed Attributes
SSO	sanitary sewer overflow
STAC	Scientific and Technical Advisory Committee
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USC	Upper Susquehanna Coalition
U.S.C.	<i>United States Code</i>
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VA	Virginia
VA DEQ	Virginia Department of Environmental Quality
VA DCR	Virginia Department of Conservation and Recreation
WIP	watershed implementation plan
WLA	wasteload allocation
WQBELs	water quality-based effluent limits
WQGIT	Water Quality Group Implementation Team
WQS	water quality standards
WV	West Virginia
WV DEP	West Virginia Department of Environmental Protection
WWTP	wastewater treatment plant
yr	year
z	depth