

**MIDPOINT ASSESSMENT PRIORITY WORK PLAN:
MEASURE AND EXPLAIN WATER-QUALITY CHANGES
LEAD: SCIENTIFIC, TECHNICAL ANALYSIS, AND REPORT (STAR) TEAM
2016-17 EXPECTATIONS**

Full Title of Priority: Enhanced Analysis and Explanation of Water-Quality Data for the TMDL Mid-Point Assessment

Short Description of Priority: The Chesapeake Bay Program (CBP) will enhance the analysis and explanation of monitoring information as part of the Mid-Point Assessment for the *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment* (Bay TMDL). The CBP partners have endorsed (PSC, May 2012) an integrated approach that includes three primary pieces of information to measure progress toward water-quality standards:

- Reporting of water-quality management practices.
- Analyzing trends of nitrogen (N), phosphorus (P), and sediment in the watershed
- Assessing attainment of DO, chlorophyll-*a*, and water clarity/SAV standards.

The activities described in this work plan will provide an integrated assessment and explanation of changes in watershed and estuary water-quality monitoring information. The four major work elements are:

- Analyze water-quality trends in the Chesapeake Bay (“the Bay”) and its watershed.
- Explain the factors affecting water-quality trends in the Bay and its watershed.
- Enhance CBP models using the improved understanding of observed trends.
- Inform management strategies to improve water quality.

The results will be used by the CBP Water Quality Goal Implementation Team (WQGIT) and other partners, through an adaptive management approach, to:

- Help prepare Phase III watershed implementation plans (WIPs).
- Inform implementing practices to carry out the WIPs.
- Evaluate progress toward improving water quality.

Partners: The effort will be coordinated through STAR with leadership from the USGS, CBP Office (Modeling and Monitoring Teams), and the University of Maryland Center for Environmental Science (UMCES). Many activities require coordination among the STAR Workgroups, which includes members from all Bay States and Washington DC, USGS, the Susquehanna River Basin Commission (SRBC), the Interstate Commission on the Potomac River Basin (ICPRB), and academic institutions.

Study Approach, Necessary Datasets, Analyses, or Decisions: The integrated approach to quantify and explain water-quality trends in the Bay and its watershed relies on monitoring information,

enhanced data on the implementation of best management practices (BMPs), and use of several analytical tools (including statistical tools, CBP WSM and estuary models, USGS SPARROW model, and GW models). The following activities will be coordinated through the CBP STAR team and interaction with the WQGIT:

- Analyze water-quality trends in the Bay and its watershed.
- Explain the factors affecting water-quality trends in the Bay and its watershed.
- Enhance CBP models using the improved understanding of trends.
- Inform management strategies to improve water quality.

Below is a brief description for each major work element, with the associated expectations (including planned products) for 2016-17. Reports already produced by the project are summarized under “deliverables” at the end of the document.

Element 1: Analyzing water quality trends in the Bay and its watershed.

This element consists of two primary items:

- Assess changes in nutrients and sediment in the Bay watershed.
- Analyze changes in water-quality in the Bay and tidal tributaries.

Analyze trends of N, P, and sediment in the watershed. The USGS will work with the CBP Status and Trends Team to provide an annual update of trends in N, P, and sediment loads for two time periods: 1985 to present, and the most recent 10 year period. The USGS will work with the STAR and CBP Office on approaches to compare and communicate the newly reported trend in flow-normalized loads (using the WRTDS method developed by the USGS) with watershed model results and Bay TMDL allocations/targets loads. Expectations for 2016-17 include:

- Release flow-normalized trend in load results for nontidal monitoring stations having at least nine years of observations through 2014. Post results on USGS trend WWW site, (and as CBP indicators), and release report summarizing methodologies to incorporate uncertainty. (USGS)
- In spring 2016, prepare and release flow-normalized loads for the nine river-input monitoring (RIM) stations and update trends through 2015 on USGS trend WWW site and as new CBP indicator. (USGS)
- Work with partners to incorporate results from nontidal network load and trend computations into mid-point assessment, milestone assessments, and WIP3 preparation. (USGS and CBP partners)
- In spring 2017, Prepare and release flow-normalized loads for the nine river-input monitoring (RIM) stations and update trends through 2016 on USGS trend WWW site and as new CBP indicator. (USGS)

Analyze trends of water quality in the estuary and tidal tributaries.

The CBP Office will work with the Maryland Department of Natural Resources (MD DNR) and the Virginia Department of Environmental Quality (VA DEQ) to summarize and communicate annual analyses of trends in tidal water quality constituents. Expectations for 2016-17 include:

- Summary report of trends in estuarine WQS attainment, 1985-2014 (CBP Monitoring Team)
- Interactive visualization tools of WQS attainment trends on chesapeakebay.net (CBP Monitoring Team)
- Presentation that communicates linkages and reasons for differences between attainment patterns and water quality variable patterns (CBP Monitoring Team)
- Summary report of 1999-2015 GAM-computed trends for secchi depth, chlorophyll-*a*, dissolved oxygen, total phosphorus, total nitrogen (CBP Monitoring Team, MD DNR, VA DEQ)
- Preliminary results on 1985-2015 trends and flow-adjusted trends in tidal WQ (CBP Monitoring Team, MD DNR, VA DEQ)

Element 2: Explain water-quality trends in the Bay and its watershed.

An integrated approach to explaining water-quality trends in the Bay and its watershed is being conducted. The effort will both geographically-specific and watershed-wide approaches to explain trends in the nontidal and estuarine areas. The team will investigate approaches for explaining trends in relation to both anthropogenic factors (including implementation of water-quality management practices and land-use changes) and natural factors (such as residence times of nutrients and sediment). The team will also work to describe the observed changes in relation to distinct “source sectors,” including wastewater treatment plants, agriculture, and urban/suburban areas. The team will advance the integration of findings to explain the relation of changes in N, P, and sediment loads from the watershed to changes in tidal water quality.

For the watershed, the team will examine the relation between observed changes in nutrient and sediment loads at selected CBP monitoring stations and factors such as: (1) changes in nutrient (such as fertilizer, manure, and air deposition) and sediment sources, (2) land-use change, (3) implementation of practices to reduce nutrients and sediment, and (4) the influence of watershed and hydrologic properties. The team will utilize a variety of statistical and analytical tools (e.g. USGS SPARROW model, ground-water models, and the CBP WSM) to help examine regional and local processes affecting trends in nutrient and sediment loads. Results from small watershed studies being conducted by USGS and academic institutions will also be used to help understand processes affecting water-quality change. The team will interface with academic partners to focus on different topics.

In the tidal tributaries and mainstem of the Bay, the team will focus on explaining changes in in DO, clarity/SAV, chlorophyll-*a*, and associated parameters. Results from the watershed efforts

described above will be used to help explain trends in estuarine water quality and associated patterns in attainment of water quality criteria. The factors to be examined include: (1) inputs of nutrient and sediment loads from the watershed, (2) implementation of practices to reduce nutrients and sediment, (3) influence of estuarine properties and processes, and (4) climatic forces. The effort will include STAR, the CBP monitoring team, the CBP modeling team, the USGS, and state and academic partners. Expectations for 2016-17 include:

- Release report of nutrient and sediment sources and changes in urban and agricultural watersheds and associated communication products summarizing key results. Winter, 2016. (USGS)
- Prepare descriptive summaries of observed nontidal trends and loads in relation to major geographic features (river basins and regions) as well as source sectors. (USGS)
- Release report describing spatial and temporal changes in land use and nutrient sources in the Chesapeake Bay Watershed to support assessments of changes in nontidal streams and estuaries. (USGS and CBP Modeling team)
- Release report describing spatial and temporal patterns of BMP implementation and expected effects across Chesapeake Bay Watershed to support assessments of changes in nontidal streams and estuaries.(USGS and CBP modeling team)
- Prepare summaries of results from a suite of ongoing regional statistical analyses linking observed changes in load with changes in land use, nutrient sources, and BMP implementation. (USGS and CBP Monitoring/Modeling Teams)
- Prepare reports describing approaches to determine ground-water age distributions in the Potomac River Basin and methods to apply this information to assessments for the Chesapeake Watershed. (USGS and JHU)
- Contribute to STAC workshop on the development of recommendations for modeling and long term monitoring to address Susquehanna Reservoir system and its impact on Chesapeake Bay.(USGS, UMCES, CBP modeling team)
- STAC GAMs Review report (CBP Monitoring Team, STAC)
- Draft results using GAMs to link all tidal stations to fall-line loads (CBP Monitoring Team, MD DNR, USGS, VA DEQ)
- Draft results linking below fall-line inputs to tidal water quality data (CBP Monitoring Team, MD DNR, USGS, VA DEQ)

Element 3: Enhance CBP Models using improved understanding of monitoring data and load delivery

The CBP modeling team will use the increasing amount and understanding of monitoring data to enhance the WSM and estuary models. The planned enhancements are explained in additional work plans that were prepared for the Mid-point Assessment of the TMDL. The USGS SPARROW and Explaining Trends teams will work with the CBP modeling team to use an improved understanding of the significance of selected variables to inform the CBP WSM. The USGS SPARROW team will also be enhancing their models to provide partners with a finer

resolution of geographic information that can be used by partners to help focus implementation of practices for the TMDL. Expectations for 2016-17 include:

In 2015, initial draft analyses were provided to the CBP modeling team from incorporation into phase 6 of the CBPWSM. In 2016, activities are focused on providing peer reviewed documents on this information.

- Publish article on SPARROW land-to-water delivery factors that are being used to improve the spatial characterization of nitrogen and phosphorus delivery in WSM. (USGS)
- Publish article on SPARROW land use delivery and septic loads that are used to support WSM calibration. (USGS)
- Continue SPARROW modeling efforts to inform selection of land-to-water and stream-to-river delivery factors for the Phase 6 WSM (CBP Modeling team, ICPRB, USGS) – Spring 2016.
- Publish articles on the determination of groundwater age distribution that are being incorporated into phase 6 of the WSM. (USGS and JHU)
- Publish articles on the role of floodplains as a source and sink for suspended sediment to support an improved characterization of sediment transport processes in the watershed model. (USGS)
- Continue efforts to integrate and compare reported changes in BMP implementation, observed changes in water quality, and expected (i.e. modeled) changes in water quality since 1985 (CBP modeling team, USGS, partners).

Element 4: Inform management strategies to improve water quality. Results of the efforts described above will be used by the CBP WQGIT and other partners, through an adaptive management approach, to:

- Help prepare Phase III Watershed Implementation Plans
- Inform implementation of practices to carry out the WIPs
- Evaluate progress toward improving water quality

The primary audiences and associated products for communicating the efforts described above include:

- Science Audience/WQGIT workgroups: Technical Reports/Journal articles.
- WQGIT; Federal and State managers on Management Board: Science Fact Sheets/tailored PowerPoint presentations/briefings.
- Implementers: local governments/conservation districts/watershed organizations: less complex and more geographically specific explanations and clear statements of implications for ongoing implementation programs and efforts.

The project team will provide key results to these groups using different communication products so they can better apply the CBP adaptive management framework to focus and

Additionally, the information will be available for inclusion into decision-support tools (such as ChesapeakeStat) and other WWW applications. This effort will require interaction between STAR and CBP Communications Office.

Expectations for 2016-17:

In 2016 and into 2017, a significant priority is to support getting the results of newly released trends and ongoing analyses into the hands of the collective partnership in a manner that supports MPA, milestones, and WIP 3 development. Key planned activities and anticipated products include:

- Convene a technical team to facilitate interaction between technical experts on the trend teams and CBP and jurisdictional representatives.
- Provide a basin characterization for the network in order to guide the use of appropriate monitoring data for support of evaluation of specific jurisdictions, watersheds, and source sectors.
- Provide selected results through Webinars (to supplement presentations provided directly to the WQ GIT).

Previous and Long-term Produces:

Products released in 2015 include:

- Eastern Shore Trends report, which explains nitrogen and phosphorus trends and conditions (USGS).
- Final STAC “Management Effects on Water Quality Trends” Workshop report (USGS and partners)
- Maps illustrating trends in N, P, surface chlorophyll-*a*, and water clarity at long-term tidal water quality monitoring stations (CBP, MD DNR, VA DEQ, partners).
- A preliminary analysis of trends in concentrations of key tidal water quality parameters at all long-term tidal water quality monitoring stations using GAMs (CBP, MD DNR, VA DEQ, partners).
- An analysis of trends in attainment of DO, chlorophyll-*a*, and water clarity/SAV criteria, using existing (as of Spring 2015) water quality standards assessment methods (CBP).
- A comparison of results using the newly developed GAMs method with results using the Season Kendall methods currently in use by the MD DNR and VA DEQ (CBP, MD DNR, VA DEQ, partners).

Potential additional longer-term products:

In addition to the products listed under each element, there are other articles and reports being considered by the team and collaborators including:

- Publish comparative study of GAMs and WRTDS application to Patuxent River estuary (UMCES, EPA ORD, USGS)

*Midpoint Assessment Work Plan:
[Analysis of Monitoring Data to Measure Progress]
Last Updated [December 9, 2015]*

- Evaluate climate-caused seasonal shifts that may complicate estuarine responses to changes in fall-line nutrient loads (CBP, academic research partners)
- Evaluate relative impact of non-tidal loads, point sources, and climatic factors on Potomac tidal water quality (ITAT Potomac Synthesis Effort team, comprised of academic and other research partners)
- Other reports and products on selected source sectors.

Level of Effort for Lead and Supporting Partners, Including (as relevant) CBPO Modeling

Team: High level of effort for CBP monitoring team, USGS, ITAT, IMWG, CAP. Moderate level of effort for CBPO modeling team.

Potential Conflicts with Other Priorities: CBP modeling team may not be able to provide effort needed to help explain trends given other commitments.

Issues Requiring Input from Full WQGIT: Prioritization of information needs, review of key findings, indicator development, verification protocols.

Issues Requiring Input from Management Board and/or Principals' Staff Committee: Approach for measuring progress has already approved by MB and PSC.