Outline: Summary of Progress for the Water Quality Standards Attainment and Monitoring Outcome

Outcome:

"Continually improve the capacity to monitor and assess the effects of management actions being undertaken to implement the Bay TMDL and improve water quality. Use the monitoring results to report annually to the public on progress made in attaining established Bay water quality standards and trends in reducing nutrients and sediment in the watershed."

Lead and Supporting Goal Implementation Teams (GITs):

Water-Quality Goal Team, carried out by STAR and its workgroups.

Participating Partners:

To be added, but most states, DC, Chesapeake Bay Commission, and several Federal agencies (EPA, USGS, FWS, and NOAA)

Overview ("compelling narrative")

The Chesapeake Bay Agreement has a goal to reduce pollutants to achieve the water quality necessary to support the aquatic living resources of the Bay and its tributaries and protect human health. Monitoring results are used to report annually to the public on progress made in attaining established Bay water quality standards and present the trends in reducing nutrients and sediment in the watershed. The assumptions in play are that:

1. directing investments into management activities that target reductions in nutrient and sediment loads from the land, air and in the water will work to reduce the amount of pollution delivered to the streams and the bay,
2. the resulting change in the amount of pollutants getting into our waterways will be sufficient to change water quality in the watershed and bay, and
3. the activities of the Chesapeake Bay long-term water quality monitoring and analysis networks and programs are capable of detecting, demonstrating and communicating the water quality change in the rivers and bay.
    a. "Change", first, as it pertains to nutrient and sediment loads delivered from the watershed and
    b. "Change", next, in habitat health status in the bay such that we detect status changes to a condition where all designated uses across all water quality standards attainment measures for dissolved oxygen, water clarity/underwater bay grasses and chlorophyll *a* meet their criteria for attainment.

However…

- In spite of an array of changes in monitoring, additional technology, and outstanding funding support that has sustained the program since 1985, we must acknowledge that **our monitoring program operates at the "marginal level"** for assessing water quality

standards attainment measures related to the TMDL – largely insufficient to measure all applicable criteria.Based on definitions of monitoring sufficiency to support Chesapeake Bay tidal water quality standards attainment assessments (USEPA 2003 p179-181) the Chesapeake Bay long-term water quality monitoring program in tidal waters **has never been at the "recommended" or "adequate" level. The nontidal (watershed) monitoring network is considered to be operating at the "adequate level"**.

- The tidal bay long-term water quality monitoring program of the Partnership was not originally designed for water quality standards attainment assessments.
- We have, however, made significant advances in providing options for improving the accuracy of our assessments (USEPA 2017).
- Advancements in analytical support do not always take the place of what greater sampling effort can do to remove uncertainty and improve accuracy in estimating the status of a water body (impaired or attaining).
- Where we do have sufficient monitoring to make the assessment of a particular criterion, we typically have low spatial or temporal resolution. Large areas may be represented by one station and a "monthly mean" is computed from no more than 2 samples leaving large uncertainties in how well we estimate conditions.
    - What this means is that analysis of monitoring program results can and does detect change in status of Bay health.
    - The change is best detected if it is large in magnitude (e.g., like the impact of a phosphate ban across a tributary basin or implementation of advanced wastewater treatment beyond previous secondary treatment to control nitrogen and phosphorus loads downstream of its outfall.)
    - The change is best detected if it impacts a large area due to fact that we have typically have large distances between monitoring stations.
    - We needed analytical techniques that use available information to estimate habitat conditions for unmeasured scales of our criteria.

Therefore…. Recommendations for overcoming limitations of our marginal support for water quality criteria attainment assessments in the Bay, and advancing the use of new data streams being developed through investments in working with volunteer monitoring programs and nontraditional partners (e.g., State, County, Federal agencies not funded under the long term water quality monitoring program but now following EPA protocols) are in place to improve our water quality standards attainment assessments.

We further recognize that model and monitoring results on nutrient and sediment loadings may suggest different trends. Our program needs to continue work to understand the comparisons of model and monitoring results

The improvement in accuracy for water quality attainment status to better track bay health and our need to ensure we our model expectations are being reflected in the monitoring findings will collectively be used by CBP to consider targeting of monitoring and management resources aimed at improving our understanding and creating better habitat health to support living resources and human dimensions across the Bay and watershed.

Our assumptions

Regarding monitoring capacity, in 2009, the Management Board provided recommendations for managing the long term water quality monitoring program by 1) rebalancing the federal funding within the existing tidal and nontidal monitoring program budget to have similar investments in the watershed and the bay, 2) funding was reduced in tidal monitoring to measurements targeting water quality criteria attainment at the existing activity levels in the field and laboratory, 3) that the nontidal (watershed) monitoring program had approximately 40 stations that were high priority to fill gaps in i) size range of watersheds monitored, ii) land use representation (e.g. agriculture dominated, urban dominated watersheds) and iii) underrepresented geographies (i.e., the modeling community in particular had very limited data from nontidal coastal plain streams relative to the distribution of sampling sites across the rest of the watershed) and 4) additional investments were made to support new analyses and data management activities associated with the expanded monitoring network and presentation of the results.

After the rebalancing actions, coupled with subsequent new investments from USEPA (i.e. approximately $2M over 2011-2012) to expand watershed monitoring program and related water quality data analysis, data management and reporting, the results of that effort provided an important road map that has sustained the direction of our monitoring efforts for a decade. To the credit of the partnership, in 2017, we stand at our greatest investment in monitoring support in the CBP history. However, there was an apparent implicit assumption that capacity would at least be stable in the face of a variety of annual stressors that can erode programming (e.g. inflation impacts on buying power of the dollar, monitoring partner portfolio changes). The work plan called for the completion of a new water quality criteria technical addendum with protocols that would allow for water quality standards to be measured using our existing, marginal sampling effort to address water quality standards attainment.

The two major issues for monitoring and analysis are the focus of the outcome:

- Continually improve the capacity to monitor and assess the effects of management actions being undertaken to implement the Bay TMDL and improve water quality.
- Use the monitoring results to report annually to the public on progress made in attaining established Bay water quality standards and trends in reducing nutrients and sediment in the watershed.

For these issues, we (1) identified factors that may hinder progress toward the outcome, (2) current efforts, (3) gaps, and (4) approaches to address the gaps.

Factors Influencing Success" that were originally identified in your Management Strategy

There is reference to resource constraints on implementing primarily WIP programming but no direct expression of factors affecting our success to sustain and growing monitoring capacity in the Management Strategy.

Success in understanding change in response to management actions through our analyses of monitoring data is impacted by the need for improved technical information as identified in the Management Strategy:

- **Improving the identification of sources and their contributions to nitrogen, phosphorus and sediment pollutant loads**

- **Quantifying the reductions from pollution control practices and verifying their continued performance**

- **Enhancing the next generation of decision support tools (Phase 6)**

- **Revisiting watershed model calibration methods with the goal of improving local watershed results**

- **Reviewing and updating historical implementation data that has been submitted by the jurisdictions to the CBP partnership, confirming that BMPs are still in place and ensuring that accurate information is included in the modeling tools**

There are several current efforts through STAR to address the water quality standards attainment and monitoring outcome. The CBP oversees the tidal and nontidal monitoring networks, which are used to (1) assess in tidal waters relative to established water quality standards and (2) measure nitrogen, phosphorus and sediment in the watershed to help determine if practices are reducing loads to the Bay and in the watershed. The tidal monitoring network is a cooperative effort between EPA, MD and VA. The watershed monitoring is a partnership between USGS, EPA, and all seven Bay watershed jurisdictions. The primary monitoring gaps include (1) more frequent measures of dissolved oxygen to assess criteria attainment, (2) greater density of measurements in segments of the bay, (3) sustaining existing watershed monitoring sites and (4) more localized monitoring in watershed areas to assess effects of BMPs.

Enhancing Monitoring

To address the factors affecting achievement of the water quality outcomes, several efforts have been undertaken. The STAR team has set up a project to better measure and explain progress toward water quality improvements. This project will generate and improve understanding of the spatial distribution of conditions and factors affecting system response (the Bay and its watershed) to implementation of management practices. STAR (under the CBP Modeling Workgroup) is also pursuing with the Scientific and Technical Advisory Committee (STAC) approaches to reduce uncertainties for models. WQGIT and STAR also are enhancing the monitoring and analysis programming to address the factors affecting annual loads, responses in living resources, and efforts underway to improve monitoring programs, including:

Water Quality Monitoring System understanding: The CBP partnership conducts annual monitoring of river flow to the Bay to help explain yearly changes in DO, clarity/SAV, and chlorophyll-a conditions. Living resources monitoring is used to assess changes in

populations of lower trophic levels (SAV and invertebrates) and fisheries (crabs, oysters and selected finfish species) that are dependent on habitat conditions. The CBP nontidal water quality monitoring program monitors nutrient and sediment at 115 sites in the watershed to help document and understand the factors affecting the response to management practices. The WQGIT and STAR intend to:

- Enhance analysis of tidal monitoring data to assess progress toward water quality standards.
- Expand the small watershed monitoring network and assessment of data to better evaluate BMP efficiency.
- Monitor shallow groundwater to understand the effect of septic systems on water quality.
- Consider monitoring shallow groundwater to better understand contribution to surface-water loads and response time between BMP implementation and water quality improvements.
- Conduct an analysis of water quality changes to better understand and explain the factors affecting water quality response to BMPs and report findings. This analysis will evaluate how nutrient and sediment transport cause lag times between implementing practices and water quality changes. This analysis will build on the USGS report on lessons learned about water quality improvements (2014 New Insights report).

Monitored Loads and Trends: The CBP partners and USGS operate the River-Input Stations to monitor and help assess annual loads of nitrogen, phosphorus and sediment to the Bay which are used to explain changes in estuary water quality conditions. New techniques are being developed to improve comparison between the nitrogen, phosphorus and sediment load data collected from the monitoring stations to TMDL allocations, which were established using the modeling tools. These techniques will be implemented at additional sites in the CBP nontidal network where possible.

What has been accomplished

Most work plan elements for 2016 and 2017 were completed through outstanding efforts across the partnership. Accomplishments include:

- Conowingo specific studies
- Development of land cover data sets
- Enhanced models
- USGS updates of watershed loads
- Application of new methods for trend assessments in the Bay and watershed
- Analyses and Syntheses that improved our understanding of bay response to loads
- Publication by USEPA of a new technical addendum that advances our approaches with protocols assessing water quality standards

A complete assessment of work plan accomplishments is attached at the end of the document in Appendix A.

Which management actions have been most critical and what do we learn?

- Investments in new analysis techniques and syntheses have greatly improved our science-based decision-support information
- Investments in enhancing models have produced better accounting and calibrations to work implemented across the partnership.
- Investments in Citizen Science are beginning to generate new data streams that can support enhanced analyses of bay health and reduce the uncertainties of present assessments.
- Publication of the new Ambient Water Quality protocols for assessment technical addendum offers states, upon adoption of the new protocols in their State standards, options and opportunities for improving their assessment of water quality criteria that previously had no approved methods for assessment and reporting with regard to their attainment status.

Which of your management actions will be the most critical to your progress in the future? Why?

- The ability to summarize vast amounts of information and findings into a format for decision makers to consider policy and prevention management approaches.
- Need to increase coordination and overcome resources constraints to summarize findings.
- Ability of States to use co-benefit information in developing and implementing Phase 3 WIPs

Are our actions having the expected effect? How should we adapt?

- Monitoring capacity has been sustained with a variety of efforts with little erosion of program outputs. However, we recognize the program is on the threshold for significant erosion without adaptation and new resources.
- One phase of adaptation will occur as States adopt and implement newly published protocols in the USEPA published Ambient Water Quality Criteria Protocols technical addendum (USEPA 2017). Techniques are available for analysis that can overcome some of the challenges presented by the marginal programming to fill data and assessment needs.
- Another phase of adaption is to use new data streams from already funded programs on citizen science, volunteer monitoring, and our enhanced coordination with nontraditional partners. This will further fill gaps in data needs over space and potentially with time scale resolution.
- Analyses have created significant synthesis to help understand our progress.
- New analysis methods developed in the last 2-year period are improving our ability to understand our progress and what is impacting trends and patterns in the watershed and bay. Further implementation and synthesis will move our understanding forward on assessing change and factors influencing change in the ecosystem.

- Further analyses are needed to understand differences between model projected change and monitoring results.

What will we ask the MB?

- Accept and promote the PSC signing of the MOU for the use of Citizen Science and Nontraditional partner data in improving our water quality assessments.
- Charge the STAR team with improving our understanding of modeling and monitoring results comparisons for nutrient and sediment loads and trends.

Appendix A. An accounting of WQGIT work plan accomplishments including monitoring and assessment elements, 2016-2017. Early accounting of new work plan elements has been included for the next period.

GIT Needs from STAR	Timeline	Completed Y/N
WQ Criteria Attainment patterns summary	June, 2016	Y
Update in patterns in WQ standards attainment DO, clarity/SAV and chlorophyll	December, 2016	Y
Publish WQ Criteria Tech Addendum	December, 2016	Published 2017
Implement new process to quantify trends in tidal WQ parameters	Annually in 2016/2017	yes, paper being completed
WQ results attained from 2 of 6 high flow events for mid point assessment	2017	yes, extended into 2017
Monitor high flow events at Conowingo	On/before May 30, 2016	yes, extended into 2017
Conowingo impacts on WQ monitoring plans	On/before May 30, 2016	DNR set up study
125 sites of nutrient and sediment samples	2016-2017	Y
Update loads and Trends USGS	2016-2017	Y
USGS to update reporting/communicating of loads to Bay	2016	Y (2016); in progress for 17
expand on BEI report for add'l monitoring needs	2016-2017	Will use this process
Incorporate Citizen Science Monitoring for WQ standards		In progress
develop targeted shallow water monitoring strategy		IN progress
Test watershed factors influencing WQ trends in tidal waters	2016-2017	In progress, 2018
Release report/communication of nitrogen sources	2016-2017	Synthesis report, 2018
Compare observed and expected trends in watershed		Synthesis report, 2018
Improve knowledge of sed and N sources		Synthesis report, 2018
Use WQ data to assess PA's progress		Ongoing
WQ functions of wetlands		Synthesis report, 2018
Improve understanding of tidal water response to load changes		Synthesis report, 2018
Develop land cover dataset	2016	Y
Enhance watershed and SPARROW model		Y
Examine Susquehanna reservoirs' impact on N and sed transport		Y
Assess N and sed response to management practices		Synthesis report, 2018
Incorporate BMP efficiencies and land cover/use	Oct. 2015 - October 2016	Y
Conduct STAC peer reviews	Winter/Spring 2016	Y

Run scenarios and modeling tools	January 2016 - September 2016	Y
Maintain and grow tidal and nontidal monitoring networks	Annual	In progress priority
TOXIC CONTAMINANT WG NEEDS TO BE ADDED.		
Approve Nontraditional Partner/Cit sci data MOU	2018	
WQ Stds Indicator Trend publication	2018	
Incorporate Citizen Science Monitoring for WQ standards (publication through Citizen Science Association journal)	2018	