Chesapeake Bay TMDL 2017 Mid-Point Assessment

Guiding Principles and Options for Addressing Climate Change Considerations in the Jurisdictions' Phase III Watershed Implementation Plans

CBP Climate Resiliency Workgroup
Briefing Document
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I. Background

The Chesapeake Bay Program (CBP) partnership is in the midst of undertaking a midpoint assessment of progress to ensure that the seven Chesapeake Bay watershed jurisdictions are on track to meet their respective 2025 Chesapeake Bay Total Maximum Daily Load (TMDL) goals. A key element of this effort is the incorporation of the latest science, data, tools and BMPs into the partnership's decision support tools to help guide implementation and to use this new information to facilitate and optimize implementation of the jurisdictions' Phase III Watershed Implementation Plans (WIPs).

Recognizing the need to gain a better understanding of the likely impacts of climate change as well as potential management solutions for the watershed, the 2014 *Chesapeake Bay Watershed Agreement* committed the CBP partnership to take action to "increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure and communities, to withstand adverse impacts from changing environmental and climate conditions." This Bay Watershed Agreement goal builds on the 2010 Bay TMDL documentation and 2009 Presidential Executive Order 13508 that called for an assessment of the impacts of a changing climate on the Chesapeake Bay water quality and living resources that is being conducted as an element of the 2017 Midpoint Assessment.

II. CBP Midpoint Assessment Decision- Making Process

The Water Quality Goal Implementation Team (WQGIT) serves as the "lead systems integrator" for the Midpoint Assessment, working with Scientific, Technical, Assessment and Reporting (STAR) Team's Modeling Workgroup and Climate Resiliency Workgroup to define the scientific and technical issues to be addressed and determining the schedule for partnership briefings and policy decisions.

A major component of the Midpoint Assessment is enhancing the CBP partnership's decision support tools, including the Chesapeake Bay Watershed Model (CBWM) and the Chesapeake Bay Water Quality Sediment Transport Model (CBWQSTM). The incorporation of key elements of the latest science on climate change is one of more significant refinements to this suite of partnership models being conducted as part of the Midpoint Assessment. The CBP

partnership's Scientific and Technical Advisory Committee (STAC) and the Climate Resiliency Workgroup (CRWG) have both provided guidance on the climate data and information to support the Midpoint Assessment modeling effort:

- STAC sponsored a workshop, "The Development of Climate Projections for Use in Chesapeake Bay Program Assessments"[1] on March 7-8, 2016 and is scheduled to conduct independent peer reviews of the Phase 6 CBWM, the CBWQSTM, and the approach being taken by the Partnership to model the effects of climate change in the Fall 2016 and Winter 2017; and,
- The CRWG developed written recommendations related to two specific climate-related data inputs and assessments to inform the Midpoint Assessment modeling effort: sea level rise projections and future tidal wetland loss assessments.[2]

In addition to providing guidance on scientific and technical considerations related to the integration of climate change effects in the Midpoint Assessment modeling efforts[3], the CRWG was tasked with exploring options for addressing climate change in the jurisdictions' Phase III WIPs.[4]

III. Incorporating Projected Influence of Climate Change into the Phase III WIPs

As part of the TMDL's Midpoint Assessment, the partnership has developed the tools and procedures to quantify the effects of climate change on watershed flows and pollutant loads, storm intensity, increased estuarine temperatures, sea level rise, and ecosystem influences, including loss of tidal wetland attenuation with sea level rise, as well as other ecosystem influences in the Chesapeake Bay watershed. Current modeling efforts, as discussed above, are underway to assess potential climate change impacts under a range of projected climate change for 2025 and 2050.

Informed by the outcomes of this climate change assessment, the CBP partnership is expected to decide, by May 2017, when and how to incorporate these climate change considerations into the

[1] See the written report for the STAC Workshop, "Development of Climate Projections for Use in Chesapeake Bay Program Assessments" (in press) for recommendations related to additional climate-related data inputs (precipitation, temperature, evapotranspiration and the application of modeling techniques and methodologies for CBP assessments.

[2] See CRWG Document, "Recommendations on Incorporating Climate-Related Data Inputs and Assessments: Selection of Sea Level Rise Scenarios and Tidal Marsh Change Models to Inform the Chesapeake Bay TMDL 2017 Mid-Point Assessment (August 5, 2016)."

[3] CBP CRWG Workplan (2016-2018) Performance Target: Conduct a review of approach to factor climate change considerations into the 2017 Chesapeake Bay TMDL Midpoint Assessment (Entity: CRWG; Modeling Workgroup; STAC)

[4] CBP CRWG Workplan (2016-2018) Performance Target: Conduct an assessment of research needs to support future policy dialog related to the integration of climate change considerations into the Water Quality Management Strategy (Entity: CRWG).

jurisdictions' Phase III WIPs. To inform this process, the CRWG was tasked with recommending a set of Guiding Principles and identifying a range options for when and how to factor climate change considerations into Phase III WIPs. In undertaking this effort, the CRWG worked under the assumption that the EPA will expect each jurisdiction to factor in the projected influence of continued climate change on Chesapeake Bay watershed pollutant loads and Bay water quality responses into their 2018-2025 programmatic and numeric commitments within their Phase III WIPs. This expectation is founded upon the CBP partnership's cumulative series of climate change related policy decisions, outcomes and goals.

The process to develop the Principles and Options for Phase III WIPs, outlined below, was purposely undertaken independently and without consideration of policy implications, regulatory requirements, political feasibility, time or fiscal constraints to provide the partnership's decision and policy making bodies with the full array of options for their consideration.

A. Guiding Principles

Climate change presents challenges to the Chesapeake Bay and its watershed in terms of both water quality and quantity. Climate change will likely increase the level of effort needed to meet the Bay TMDL reduction goals; it could also lead to changes in the total nutrient and sediment pollutant loads the Bay ecosystem can assimilate and still meet the four Bay jurisdictions' Chesapeake Bay water quality standards. To proactively work to address these challenges, the jurisdictions should adhere to the following principles when developing and implementing Phase III WIPs:

WIP Development:

1. *Capitalize on "Co-Benefits"* – maximize BMP selection to increase climate or coastal resiliency, soil health, flood attenuation, habitat restoration, carbon sequestration, or socio-economic and quality of life benefits.
2. *Account for and integrate planning and consideration of existing stressors* – consider existing stressors such as future increase in the amount of paved or impervious area, future population growth, and land-use change in establishing reduction targets or selection/prioritizing BMPs.
3. *Align with existing climate resiliency plans and strategies* – align with implementation of existing greenhouse gas reduction strategies; coastal/climate adaptation strategies; hazard mitigation plans; floodplain management programs; fisheries/habitat restoration programs, etc.
4. *Manage for risk* and p*lan for uncertainty* – employ iterative risk management and develop robust and flexible implementation plans to achieve and maintain the established water quality standards in changing, often difficult-to-predict conditions.
5. *Engage Local Agencies and Leaders* – work cooperatively with agencies, elected officials, and staff at the local level to provide the best available data on local impacts

from climate change and facilitate the modification of existing WIPs to account for these impacts.

WIP Implementation:

1. *Reduce vulnerability* - use "Climate-Smart" principles[5] to site and design BMP's to reduce future impact of sea level rise, coastal storms, increased temperature, and extreme events on BMP performance over time. Vulnerability should be evaluated based on the factor of risk (i.e. consequence x probability) in combination with determined levels of risk tolerance, over the intended design-life of the proposed practice.
2. *Build in flexibility and adaptability* - allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options (load allocations, BMP selections, BMP redesign). Use existing WIP development, implementation and reporting procedures, as well as monitoring results and local feedback on performance, to guide this process.
3. *Adaptively manage* - Allow for changes in BMP selection or WIP implementation, over-time, as new climate and ecosystem science, research, or data becomes available and the understanding of the impact of how changing seasonal, inter-annual climatic and weather conditions may affect the performance of watershed restoration practices. Consider new science on climate change impacts in future BMP Expert Panels, following the CBP partnership's BMP Expert Panel Protocols[6].

B. Menu of Options for factoring climate change considerations into the jurisdictions' Phase III Watershed Implementation Plans

Current modeling efforts are underway to assess the impacts of climate change under a range of projected climate change for 2025 and 2050. Informed by the outcomes of this climate change assessment, the CBP partnership is expected to decide, by May 2017, when and how to incorporate these climate change considerations into the jurisdictions' Phase III WIPs. To inform this process, which will be undertaken in tandem with a review of the climate change assessment approach and preliminary and final modeling results, the CRWG has developed the following array of options for addressing climate change in the Phase III WIPs for CBP partnership consideration.

At this stage in the process (with Midpoint Assessment climate change modeling results pending), the options should be viewed as conceptual in nature. The options should be

[5] Additional resources, reference material and training will need to be developed to assist jurisdictions with implementing "climate-smart" siting and design principles.

[6] http://www.chesapeakebay.net/channel_files/22733/cbp_bmp_expert_panel_protocol_wqgit_approved_7.13.15.pdf

considered as a full array, recognizing that some options may be deemed non-viable based on a review of the modeling results. The options listed below range from a comprehensive approach to assessing and addressing climate change, to a narrower set with more limited implementation. The timescales for implementation of specific options also varies. In evaluating these options, CBP partnership decision and policy making bodies should consider the full menu outlined below (see Table 1), understanding that several options could be combined for implementation.

Table 1. Menu of Options for Factoring Climate Change Considerations into Phase III Watershed Implementation Plans

Menu of Options			
Option	**Description**	**Implementation Considerations**	**Pros/Cons/Technical Considerations**
#1: Factor Climate Change into the Bay's Assimilative Capacity.	The annual total nutrient and sediment pollutant loads that the CB ecosystem can assimilate and still meet the four Bay jurisdictions' CB water quality standards will be revised based on 2025 or 2050 climate change projections (i.e., CBWQSTM climate model results) that result in a direct effect on the Bay's ecosystem and internal processes (e.g., water column temperature, changes to stratification, loss of tidal wetlands, change in sea level).	This option will likely result in an explicit increase in the level of effort required to meet the CB water quality standards. The decision to select this option will require consideration of the results and level of confidence in existing climate modeling runs. The partnership could consider whether the model simulated changes in the assimilative capacity of the Bay are significant enough to make such a change.	*Pro:* Comprehensive approach; quantitative analysis and response. *Con:* This option would increase the level of effort required to meet water quality standards. To offset anticipated changes in loads due to climate change, a greater level of effort (i.e., BMP implementation) will be needed. *Technical Feasibility:* The decision support tools exist to implement this option in sequence with other decisions related to development of the Phase III WIP planning targets.
#2: Factor Climate Change into Phase III WIP' Base Conditions	Use either the 2025 or 2050 climate projection scenarios as base conditions (informed by CBWM climate modeling results) in the establishment of the jurisdictions' Phase III WIPs. The climate change projection would be an added load that the jurisdictions would need to address in addition to their Phase III WIP planning targets, thereby increasing the level of effort.	Addressing climate change as part of the base conditions does not change the assimilative capacity of CB, nor the Phase III WIP planning targets. The decision to select this option will require consideration of the results and level of confidence in existing climate modeling runs. The partnership will have modeling output results now, but there will be uncertainty and projections may change over time.	*Pro:* Comprehensive approach; quantitative analysis and response. *Con:* This option would increase the level of effort required to meet water quality standards. To offset anticipated changes in loads due to climate change, a greater level of effort (i.e., BMP implementation) will be needed. *Technical Feasibility:* High in near-term. The decision support tools exist to implement this option in sequence with other decisions related to the development of the Phase III WIP planning targets.
#3: Commit to Factor Climate Change into the	The projected impacts of climate change in 2025 and 2050 will be assessed and	This option would put off any quantitative response to	*Pro:* Would establish the partnership's commitment to addressing climate change but

Bay's Assimilative Capacity (Option 1) and/or into Phase III WIP Base Conditions (Option 2) with Deferred Implementation until 2025 or beyond.	relayed to the jurisdictions, but they will not be explicitly factored into the Bay's Assimilative Capacity or incorporated into the Phase III WIP Base Conditions. However, the partnership would establish a timeframe (e.g., 2025, 2030, 2035, etc.) for when climate considerations would be factored into the TMDL and/or Base Conditions.	addressing climate change until after the Mid-Point Assessment but would establish the partnership's commitment to doing so within a specified timeframe. To inform considerations post-2025, additional climate change assessments and modeling efforts would be required.	give us more time to assess impacts and understand and develop response options. *Con:* This option would put off any quantitative response to addressing climate change until after the Mid-Point Assessment. *Technical Feasibility:* High in near-term. The decision support tools exist to implement this option.
#4: Factor Climate Change into a Bay TMDL Margin of Safety.	Allocate a specific pollutant load reduction as "explicit" margin of safety to account for any lack of knowledge concerning the relationship between load and waste-load allocations and achieving the four Bay jurisdictions' CB water quality standards. Factors to consider when making "margin of safety" determinations include: a. uncertainties related to potential climate change effects and modeling processes; b. degree to which nitrogen, phosphorus and/or sediment loads due to climate change are likely to impact water quality; and/or c. whether jurisdiction implementation strategies include measures that will mitigate possible increased nutrient and sediment pollutant loads due to climate change.	This option will likely result in an overall increase in the level of effort required to meeting the Bay jurisdictions' Chesapeake Bay water quality standards. However, this option does not directly result in a clear delineation of which jurisdictions/major basins are responsible for the additional nutrient/sediment load reductions due to projected climate change impacts. The margin of safety would account for recognized climate impacts but acknowledges a lack of precision at assessing impacts on specific source sectors or geographic scales. The Partnership would need to determine how to allocate the level of further nutrient and sediment load reductions assumed under the "margin of	*Pro:* Provides for quantitative analysis and response. This option would reduce overall level of risk in the long-term. *Con:* This option would increase the level of effort required to meet water quality standards. To offset anticipated changes in loads due to climate change, a greater level of effort (i.e., BMP implementation) will be needed. *Technical Feasibility:* High in the near-term. The tools exist to implement this option in sequence with other decisions related to the planning targets.

		safety" among the jurisdictions by the major basins.	
#5: Factor Climate Change into Phase III WIP BMP Optimization.	During the development of Phase III WIPs, jurisdictions' would prioritize the selection of BMPs that will better mitigate the anticipated increased nitrogen, phosphorus and sediment loads due to the projected effects of climate change through 2025 or 2050.	Additional research would be needed to support full implementation of this option over time. Implementation of this option would require engagement with source sector workgroups involved with BMP expert panels to determine whether there is a sound scientific understanding and the technical capacity assess the likely impact of climate change on BMP efficiencies over time.	*Pro:* Ensures selection of BMPs in the Phase III WIP would include consideration of projected climate change conditions. This would help the jurisdictions optimize their reductions from nonpoint source BMPs over the long term, since the effectiveness of some BMPs could be more susceptible than others due to changes in climate. *Con:* Lack of technical understanding of the response of almost all CBP partnership approved BMPs to changes in hydrologic and meteorological conditions. *Technical Feasibility:* Near-term technical feasibility to support full implementation of this option is low.
#6: Adaptively Manage Phase III WIP BMP Implementation (Post Phase III WIP development).	During each two-year milestone development period, jurisdictions would consider new information on the performance of existing BMPs, including the contribution of seasonal, inter-annual climate variability and weather extremes on BMP performance. When there is a detectable impact on the effectiveness of a BMP performance, jurisdictions would use this information to re-prioritize the selection of BMPs to implement in the Phase III WIPs that will better mitigate the anticipated increased in nitrogen, phosphorus and sediment loads.	This option would not affect the development of Phase III WIPs, but would come into play during each two-year milestone period. To inform implementation, the WQGIT and source sector workgroups would need to work together to assess how the jurisdictions, BMP expert panels, and the partnership in general could facilitate the collection and evaluation of BMP performance data.	*Pro:* This option would enable the partnership to learn more about BMP performance and the sensitivity of BMPs that are attributable to climate change, to allow for consideration of these factors while adaptively managing for long-term change. *Con:* Implementing this option as a stand-alone would put off making any substantive or quantitative approach to addressing climate change in the near-term. This option would require additional monitoring and assessment efforts. *Technical Feasibility:* Near-term technical feasibility to support full implementation of this option is low.
#7: Factor Climate Change into Programmatic	The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions. Jurisdictions would provide a narrative that describes	This option is qualitative in nature but would encourage jurisdictions to use local expertise and knowledge along with the	*Pro:* This option allows for flexibility in jurisdictions' approaches to addressing climate change, and can incorporate local knowledge and information where quantitative data may be

Commitments with Set Expectations.	their programmatic commitments to address climate change in their Phase III WIPs. Jurisdictions are expected to consult the Guiding Principles when developing their narratives. Narratives may vary among jurisdictions, but would include a description of their method(s) for gathering and assessing scientific data and information, their conclusions based on that information, and how those conclusions guide their programmatic commitments.	latest climate information and science to inform their programmatic commitments. Commitments will vary across jurisdictions but could include such activities as: undertaking demonstration projects, prioritizing implementation of climate-smart programs and BMPs; approaches for assessing vulnerability of planned BMPs; or enhancing plans, policies, regulations or on-the-ground efforts to address impacts, etc.	lacking. It also provides standard elements to be addressed across narratives to provide for accountability and consistency across proposed narratives. *Con:* Options that rely on quantitative information may provide for learning across jurisdictions about methods and results that work well for addressing projected climate changes. While the programmatic commitment option is more flexible than other quantitative options, methods and results are highly individual and are therefore not likely to lead to information that is replicable across jurisdictions. Providing an option for programmatic commitments may also cause some jurisdictions to avoid using quantitative approaches when they are technically able to do so to address climate change. *Technical Feasibility:* Medium in near-term.

IV. Decision-Making Guidance

The Options should be viewed as a menu, not an exact gradation of alternatives from most comprehensive to least. More than one option, time-step alternative, or components thereof, could be selected. That said, the most comprehensive package of options, would include selection of Options #1, #2, #5,#6 and #7; while, the selection of #8 would be addressing climate change with the least level of specificity. See Table 2 for additional packaging options and alternatives. The CRWG recommends that the WQGIT fully consider the options listed above, as well as a combining options and considering varying time-step alternatives as well as implementation timeframes (pre or post-Phase III WIP development). An example of this approach would be:

> *"Factor 2025 Climate Change into Phase III WIPs' Base Conditions with BMP Optimization for 2050 Climate Change.* Use the 2025 climate projection scenarios as base conditions in the establishment of the Phase III WIPs. Jurisdictions would develop Phase III WIPs that would offset increased loads due to 2025 projected climate change. In addition, the jurisdictions would use climate change impacts projected through 2050 to directly inform the selection of BMPs and geographic areas to be targeted for implementation."

Table 2: Packaging of Options & Alternatives

Option	Option Title	Related Model Components	Time-Step Alternatives		Potential Combinations	Guiding Principle
1	Assimilative Capacity	CBWQSTM	a. 2025	b. 2050	Stand-alone or combine with #2, #5, #6 and/or #7	Reduce Vulnerability; Manage for Risk
2	Base Conditions	CBWM	a. 2025	b. 2050	Stand-alone or combine with #1, #5, #6 and/or #7	Reduce Vulnerability; Manage for Risk
3	Commitments with Deferred Implementation	CBWQSTM and CBWM	To be established		Stand-alone or combine with #5, #6 and/or #7	Manage for Risk; Plan for Uncertainty; Flexibility and Adaptability
4	Margin of Safety	N/A	N/A	N/A	Stand-alone	Manage for Risk; Plan for Uncertainty
5	BMP Optimization	CAST with optimization capability	2025	2050	Stand-alone or combine with #1, #2, #3, #6, and/or #7	Reduce Vulnerability; Co-Benefits
6	Adaptively Manage	CAST with optimization capability	In line with 2-Year Milestones		Stand-alone or combine with #1, #2, #3, #5, and/or #7	Plan for External Stressors;

					Flexibility and Adaptability
7	Programmatic Accounting with Set Expectations	CBWQSTM and CBWM	N/A	Stand-alone or combine with #1, #2, #3, #5, and/or #6	Reduce Vulnerability; Align with existing programs and strategies

V. Schedule for Midpoint Assessment Climate Change Considerations

The timeline for the integration of climate change considerations into the Midpoint Assessment and specific deliverables and key management decisions, along with responsible CBP partnership coordinating bodies, is outlined below.

Deliverable/Decision	CBP Decision-Making Lead(s)	Timeline
Technical Workshop on climate change projections for use in CBP assessments	STAC, STAR Modeling Workgroup	March 7-8, 2016
Recommend CBWQSTM model data inputs related to: sea level rise projections and tidal wetland loss assessment methodology	STAR Climate Resiliency Workgroup	May –August 2016
Develop initial climate change analysis with all CBP partnership models	STAR Modeling Workgroup	June – July 2016
Modeling Quarterly Review (initial review of climate data and analysis)	STAR Modeling Workgroup	August 9-10, 2016
Exploration of options for incorporating climate change findings in Phase III WIPs	STAR Climate Resiliency Workgroup	September 19, 2016
Independent peer review of the CBP climate change modeling approach	STAC, STAR Modeling Workgroup	October – December 2016
Modeling Quarterly Review (review of climate data and analysis)	STAR Modeling Workgroup	October 4 and 13, 2016
Review of proposed CBP climate modeling approach and initial formulation of options for Phase III WIP incorporation	WQGIT	October 24-25, 2016
Approve WQGIT recommendations on the proposed CBP climate modeling approach and initial formulation of options for Phase III WIP incorporation for presentation to the Principals' Staff Committee	Management Board	November 17, 2016
Decision on proposed climate assessment procedures and proposed range of options for factoring climate change into Phase III WIPs	Principals' Steering Committee	December 13, 2016

Final calibration of Phase 6 model, including all climate change components	STAR Modeling Workgroup	January – March 2017
Partnership decisions on when and how to incorporate climate change considerations into the jurisdictions' Phase III WIPs	WQGIT, Management Board and Principals' Staff Committee	January - March 2017
Partnership fatal flaw review of final suite of Phase 6 partnership models	CBP partners	March – May 2017
Release of final Phase 6 model	STAR Modeling Workgroup	June 2017
Release of draft Phase III WIP Planning Targets	EPA	June 2017
Release of final Phase III WIP Planning Targets	EPA	December 2017

VI. Next Steps

This document lays out proposed guiding principles and a range of options on when and how to incorporate climate change considerations into the jurisdictions' Phase III WIPs. The CRWG will continue to stay abreast of the approach and process to address climate change in the Midpoint Assessment. At the request of the Chesapeake Bay Program partnership, the CWRG can provide additional support related to climate data needs or guidance on application to modeling or policy related decision-making processes.