STAC Independent Peer Review Panel Questions for the Phase 6 Model Review

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CBP Groups Supported: Water Quality Goal Implementation Team (WQGIT) and the Modeling Workgroup

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Introduction:

The Phase 6 is the most recent of a series of increasingly refined versions of the Chesapeake Bay Watershed Model developed since 1982. Different versions of the model have been operational for more than three decades guiding Chesapeake Bay Program (CBP) management decisions. However, Phase 6 is a major departure from previous deterministic and mechanistic versions which were largely based on a highly modified HSPF framework. While the deterministic HSPF framework is persevered in the hydrologic and sediment simulations, the water quality simulation is an entirely new approach which relies on a structure based on multiple models. The CBP, though the Modeling Workgroup, requests a STAC review of the Phase 6 Model with particular emphasis on the new multiple model aspects of the watershed simulation.

Reports to be Reviewed by the Panel:

Beta 3 Phase 6 Model documentation:
ftp://ftp.chesapeakebay.net/Modeling/Phase6/Ph6Calibration_Beta3/Documentation/

Resource Materials for the Panel:

Linker, L.C., G.W. Shenk, P. Wang, R. Batiuk, 2008. *Chapter 3: Integration of Modeling, Research, and Monitoring in the Chesapeake Bay Program* in Management of Water Quality and Irrigation Techniques, Editors: Jose Albiac and Ariel Dinar, Earthscan. London, UK.;

Shenk, G.W., J Wu, L.C. Linker, 2012. An Enhanced HSPF Model Structure for Chesapeake Bay Watershed Simulation. J. Environ. Eng. 2012.138:949-957.

Shenk, G.W. and L.C. Linker, 2013. Development and application of the 2010 Chesapeake watershed total maximum daily load model. J. Am. Water Resour. Assoc. 49:1042–1056. doi:10.1111/jawr.12109

Linker, L.C., R.A. Batiuk, G.W. Shenk, and C.F. Cerco, 2013. Development of the Chesapeake TMDL Allocation. J. Am. Water Resour. Assoc. 49:986–1006. doi:10.1111/jawr.12105

Phase 5.3 Watershed Model Documentation:
http://ches.communitymodeling.org/models/CBPhase5/documentation.php#p5modeldoc

Phase 6 Peer Review Questions:

The Chesapeake Bay Program (CBP) partnership requests a scientific review that directly addresses the following questions. The review committee may also make recommendations for future work by the CBP partnership that build on the questions or are related to the scientific or management issues raised in the Phase 6 peer review. The review committee will be provided with the relevant documentation and will be given full access to CBP modeling practitioners to facilitate the review. The review committee will generate a written report addressing the questions for submittal to CBP through the chairs of the Modeling Workgroup and the Modeling Coordinator. The Modeling Workgroup will ensure the STAC peer review record includes responses to the peer review panel's comments.

1) Please comment on the overall appropriateness of the approach taken in the Phase 6 structure of a deterministic hydrology and sediment transport management model combined with a nutrient model informed by multiple models and multiple lines of evidence as described in **Section 1**. Please comment on the multiple model structure of the Phase 6 nutrient simulation particularly to its utility to watershed management in the Chesapeake restoration? How can the Phase 6 multiple model approach be improved going forward?

Expertise Needed: Management-focused Watershed Modeling

2) Please comment on the scientific rigor of the methods used for the average nutrient export rates described in **Section 2**. Are they calculated appropriately? Is there any additional scientific information that should be included?

Expertise Needed: Management-focused Watershed Modeling

3) In **Section 4**, how justified are the sensitivities of nutrient export from land uses to nutrient inputs, given the approach used and data available? Do the sensitivities to nutrient inputs derived from multiple models reflect our best understanding of the current condition of nutrient load processing and attenuation on the landscape? Is there any additional scientific information that should be included?

Expertise Needed: Nutrient Dynamics

4) Please comment on the scientific rigor of the methods used in the use of Spatially Referenced Regression On Watersheds (SPARROW) for land to water factors in **Section 7**. Are they reasonably implemented? Is there any additional scientific information that should be included?

Expertise Needed: SPARROW modeling

5) Please comment on the overall appropriateness of the methods used in the application of multiple methods to estimate stream-to-river factors for nutrients in **Section 9**? Is there additional scientific information that should be included?

Expertise Needed: SPARROW and other empirical methods

6) Please comment on the scientific appropriateness of the approach taken for Phase 6 lag times described in **Section 10** given the current state of information and understanding of groundwater and particulate processes. How can the structure and processes of nutrient lag time simulation on the land be improved in Phase 6 or future watershed model applications? Is the application of

the Ranked Storage Selection (rSAS) function for groundwater nitrate and Unit Nutrient Export Curves (UNEC) for all other nutrient species appropriate for the management questions?

Expertise Needed: Lag time estimation

7) Please comment on the scientific rigor of the methods used in the Phase 6 sediment simulation components using a detailed Revised Universal Soil Loss Equation 2 (RUSLE2) (**Section 2**), an interconnectivity metric (**Section 7**), and the inclusion of sediment source/sink estimates from stream banks and flood plains (**Section 9**).

Expertise Needed: Large-scale sediment modeling

8) Given the fine scale 1m x 1m land use data that's used in Phase 6, what opportunities does this open to the CBP and scientific community in the next phase of watershed model development? What are the advantages in a distributed representation of hydrology, land cover, and sediment? Given the availability of nutrient inputs from Agricultural Censes at the county scale only does a higher resolution of the watershed model make sense?

Expertise Needed: General watershed modeling

9) Better simulation of the deposition and scour processes in the reservoir reach of the Lower Susquehanna is an important feature of the Phase 6 Model. It is crucial to 2017 Midpoint Assessment decision making to be able to represent the net deposition of sediment, nitrogen, and phosphorus in this reach of the Susquehanna as fully as possible. Does the Phase 6 representation of the dynamics of the reservoir system rely on the best science available at this time? Do the simulations approximately represent the observed changes in storage of sediment, nitrogen and phosphorus as seen in the historical record from the last few decades? How can the representation of Conowingo infill be improved going forward beyond the Phase 6 Model?

Expertise Needed: Sediment processes including deposition, biogeochemical processes, and scour.

10) Please comment on the scientific appropriateness of the methods used in the representation of climate change in watershed nutrient and sediment loads estimated for the 2025 and 2050 time periods. How well to the models used for producing future climate scenarios show skill in hindcasting the actual climatic and hydrologic changes that have happened over the past several decades?

Expertise Needed: Watershed effects of climate change

11) For longer term CBP considerations, how can the overall approaches and procedures used in Phase 6 be improved and what alternative approaches and data gathering might you recommend?

Expertise Needed: Management-focused watershed modeling

12) Please comment on the Phase 6 documentation. Is it clear, well organized, concise, and complete (taking into account that it is the third Beta out of an expected four Beta versions and about six months ahead of final release)?

Proposed Peer Review Schedule and CBP Partnership Response

The CBP partnership requests that the STAC convened independent scientific peer review panel complete their review and deliver a panel report reflecting the Panel's collective written responses to above questions by mid-October. The CBP partnership is committed to providing written responses to the Panel's collective responses to above questions by November 15, 2016.

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