Modeling Workgroup Quarterly Meeting Minutes
July 21-22, 2015

CBPO Fish Shack, 410 Severn Avenue, Annapolis, MD 21403
Event Webpage: http://www.chesapeakebay.net/calendar/event/22834/

Minutes: July 21, 2015
Able to identify dependencies, and develop a framework for review for the 2016 time period.

Review of Modeling Workgroup 2015-2017 Activities – Lee Currey, MDE - Dave Montali, WVDEP
Attachment A.1, *Attachment A.2*

- The next Modeling WG Conference Call is scheduled for September 3.
- In the schedule, the Modeling WG is answering questions concerning why we are updating the tools in place.
- Comments about the long term schedule should be sent to Kyle Hinson as well as the Modeling Workgroup leadership.
- The bottom line for meeting 2025 goals is that the partnership needs to be able to engage the local partners, and take healthy steps in adaptive management. The Phase 3 Watershed Implementation Plans will determine how to move from 2017 to 2025 based on this collaboration.
- The model also builds on the strengths of previous models
- Modeling WG consensus still needs to be reached for targets as well as the sediment delivery ratios.
- ACTION: Develop a graphic of new monitoring stations added, with different time extensions added in the new version of the model.
- A decision is also needed concerning efforts to model phosphorus, to be decided once Guido presents.
- The simulation period for the WQSTM is also to be extended to 2014, like the extension already completed for the Watershed Model.
- Focus on shallow water with the water quality model, a thing to watch in the WQSTM is the reactivity which is important for Conowingo and climate change.
- There will be an addition of approximately 4,000 reservoirs in SPARROW to the WSM.. This fits in with the river simulation of N, P, and sediment, and is an improvement to the river water quality simulation.
- STAC reviews need to be specific and should focus on that which is new to the model. A peer review of the WSM will be in February 2016. A Conowingo modeling workshop will be held in April 2016, and will consider how to best incorporate enhanced monitoring currently underway at Conowingo Dam as well as the latest reservoir infill research into the models (WSM and WQSTM). In the summer of 2016 two STAC reviews will address an approach to address impacts of climate change (CC) as they pertain to 2025 goals, as well as peer review of the WQSTM.
- The first STAC CC workshop will recommend standard inputs and approaches to climate analysis by the Bay Program. The review is not specific to the Modeling WG, although the WG is involved.
- The second STAC CC workshop will specifically review the CBP climate change modeling approach using the CBP airshed, WSM, and WQSTM models.
- **ACTION**: Gary to add details of the STAC reviews to the document that Lee is presenting.
- In extending the calibration window for phosphorus, are there new calibration stations coming online, especially in the Delmarva area?
    - Much of the Eastern Shore data are not suitable for calculating loads, because they sample a few times a year during low flows. UMCES efforts should hopefully be

available for the WSM calibration this year and a few new stations are coming online in the near future.
    - The new stations should be added to a list of points regarding efforts to better determine what is driving changes in phosphorus.

Phase 6 Watershed Model Schedule Update – Gary Shenk, USGS
Attachment B

- Gary reviewed the upcoming schedule and deadlines for the development of the Phase 6 model, outlining the tasks still to be completed as well as the progress that has been made thus far.
- October 1 is the deadline that has been set to submit information that will be used in the calibration of the Phase 6 model.

Phase 6 Development Progress – Gopal Bhatt, Penn State
Attachment C

- Gopal reviewed the evolution of P6, and the incorporated suggestions provided by the Modeling WG. In addition, several parameterization and calibration components were also discussed.
- WRTDS loads for 2013 and 2014 are expected to become available later in 2015.
- Q: Why do you think land uses generated points out at the top and bottom of Phase 6 Nash-Sutcliffe efficiency diagrams?
    - This could potentially be attributed to the fact that to date the hydrology calibration has been performed on previously used acres, i.e., Phase 5 acres. The variance is also expected to increase as the length of the calibration period increases.
- When the monthly load efficiency is compared to WRTDS results, the simulation performs very well across all major basins with the exception of the Mattaponi.
- The phosphorus sensitivities that were used were based on Guido's analyses of APLE for three different land uses. The three sensitivities will be mapped to multiple land uses and in the next model prototype, the full suite of sensitivities from APLE with corrected application rates will be utilized.

Agriculture Land Use Loading Rates – Tom Jordan, SERC – Gene Yagow, VA Tech
Attachment D

- Tom and Gene provided a review of the Agricultural Modeling Subcommittee's work in developing agricultural land use loading rates.
- Efforts are underway to look at relative rates to break out the subsurface vs. surface loading components on nitrogen. The group also hopes to have an opportunity to review RUSLE2 at the end of July and modify what has been shown to date.
- For nitrogen, the Agricultural Modeling Subcommittee intends to rely on the literature, and sediment and phosphorus are to be determined with the help of APLE and RUSLE2.
- There was discussion regarding differences in the development of land uses for an urban and an agricultural approach.
    - The model is not being used to state that there are differences between land uses, rather the sensitivities that were developed as part of the modeling effort are being utilized to drive the efforts between separate land uses.
    - The crop type is also not necessarily driving the differences in agricultural land uses, as other important factors carry more weight in distinguishing the different land uses.

    - The ratios between the different agricultural land uses are will be incorporated into the targets developed by Olivia.
    - Motivation for the multitude of different land uses are driven by distinct loading rates, particular BMP's, or for management reasons.
    - The role of the Modeling WG is to address these points concerning different land uses when they affect model calibration results.
    - Alisha Mulkey noted that if there is an intent to modify RUSLE2 erosion rates, it may be prudent to also consider the annual runoff estimates. Surface targets have been used as the preliminary research, but Guido has done modified work with interflow targets that produce a better distribution of sediment loss in the overland flow. Using Mehlich 3 to break out differences between pasture Mehlich 3 and crop Mehlich 3 may also be useful.
- Relative loading rates are enforced at the watershed scale, but locally those ratios may vary based on local application rates.

Phase 6 Model Land Use – Peter Claggett, USGS
Attachment E

- Peter provided an overview of the land use development schedule and process that is underway for the development of the draft dataset.
    - The final land use dataset will be extensively reviewed by both state and non-governmental partners throughout the year.
- The impact that wetland efficiencies will have is potentially large, but essentially unknown. Upslope land uses are affected by wetlands significantly, and loads from all land uses in the watershed might be reduced by 5, 10, or 20 percent on average.
- Extractive land use is still on the back burner. Constructed and harvested acres are still being collected and will be reported by state partners rather than being classified by imagery.
- Some of the sewer service areas have been updated based on a weight-of-evidence approach, and others have been based off of state provided data.
    - Breaking down federal wastewater discharge for non-residents has been problematic, and issues are being addressed regarding the identification of sewer areas and septic points in high density areas.

Final Phase 6 Land Use Targets – Olivia Devereux, Devereux Consulting
Attachment F

- Olivia provided an overview of the completed nutrient targets, discussing improvements, and the role that the process plays in improving transparency in modeling efforts. She also reiterated methodologies and decisions made in target development.
- Monitored loads are used to set the targets. These loads are comprised of indicator loads from WRTDS which encompass the 9 RIM stations in addition to the below RIM point sources. The load is also added to the WSM below RIM loads, which are corrected to the difference between the modeled and monitored loads. In this way, the bias of flow in the WSM for that specific year is removed.
- Are the nutrient species informed by monitoring or modeling?
    - They are split up using some ratios from Phase 5. There may be additional information in the literature review that may be helpful to inform a last pass through.
- It is important to keep in mind that loads are subject to modification through the calibration, even though the relative differences among land uses are set.
- What makes the method especially applicable is its scalability throughout the entire watershed.
- Are these loads edge of stream loads or delivered loads?

    - These loads denote the edge of stream, and edge of small stream loads (also accounting for land to water factors).
    - Overall the load estimate comes from the monitored load (with point sources removed), and that is backed up with a factor for the edge-of-small-stream.
- A check step may be to look at the river input monitoring stations, which will more or less be completed when Gopal runs the model.

Sensitivity to Phosphorus Inputs – Guido Yactayo, UMCES
Attachment G

- Guido provided an update about the motivations and methodologies behind the development and implementation of phosphorus sensitivities.
- The simulation period was extended with the finding that a 40 year run does not modify many of the findings.
- Alisha helped to provide a more nuanced explanation of the Mehlich value discussed.
    - The Mehlich is kind of a crop's response to additional P input, and is not necessarily associated with the sediment load. Mehlich is the quantification of the concentration in the soil based on the extraction used. So, Mehlich 3 is not the only soil phosphorus extraction. There's a degree of variability based on the kind of soil phosphorus extraction occurring, and how that number is translated or interpolated. Mehlich is how the crop responds to additional phosphorus inputs, not necessarily the value of the crop uptake.
- The sensitivity for urban areas is based on the recommendations from the Urban Nutrient Management Panel, meaning that the good agreement with the Phase 5 estimate was rather serendipitous.
- **ACTION**: Line up a discussion regarding urban phosphorus, stream concentrations, and sensitivities of urban areas for the next Modeling WG call in September.
- There were no objections among those present at the meeting to continue moving ahead with determined sensitivities for cropland phosphorus in the model's second prototype.

Chester River Shallow Water Multiple Models – Jeremy Testa, UMCES
Attachment H

- Jeremy discussed the preliminary simulations of hydrodynamics in the Chester River and some of the work completed on the biogeochemical simulation.
- The model is run on the ROMS (Regional Ocean Modeling System) platform. There is also an application of FVCOM being employed. This model has fairly high resolution at about 70 meters. There are 10 vertical layers, and initial simulations were forced by a single freshwater input at the head.
- The scale of the model makes it impractical to apply everywhere, although it does produce a useful comparison for models that have less resolution in the Chester. The model associated with these efforts has more than 38,000 cells.
- Eventually there will be runs completed for 8 years so that comparisons of variability can be made on an inter-annual basis as well as seasonally.
- There were issues noted with improper boundary forcing and salinity simulations.
- Despite some of the inadequacies in the initial runs, the model is able to capture some of the stratification present in the Chester River.
- Progress is also being made in producing some preliminary benthic algal components of the modeling system.

MINUTES: July 22, 2015

Full Representation of Diagenesis in WQSTM Sediments and Water Column – Carl Cerco, U.S. CoE ERDC
Attachment I

- Carl described progress in the calibration of the WQSTM mainstem using full representation of all of the G1 (labile), G2 (refractory), and G3 (inert) organic fractions in the water column to match the same G series in the sediment.
- In the past there existed the potential to vary the split of water column phosphorus, but this could only be done spatially, and not as a load source. This became problematic when adding the bankloads, because of the inability to partition bankloads to G3 inert exclusively.
    - There are now three reaction classes in the water column and the sediment, so that any loading source can be split precisely.
- In every single system with Phase 5.3 and the TMDL model the values of nitrogen were low, and now in every single system nitrogen values are high. This was posited as potentially due to the influences of previous calibration?
- There are much greater levels of total suspended solids throughout the model. There are also large increases in phosphorus from the April calibration run.
- Obtaining correct chlorophyll values is a real balancing act among growth, predation, and uptake rates, as well as respiration rates.
- **Linker Linkage**: The Modeling Team may be able to help by working on a sort of limitation analysis, using Michaelis-Menten techniques.
- There is an increase in TSS in the lower Bay that was not captured before, and there is some process occurring that contributes to a persistent peak in the lower Bay.
- The process by which dissolved inorganic phosphorus precipitates out is not currently included in the model. Currently there is a great deal of excess phosphate in the model.
- Total solids are high everywhere, and especially at station CB1.1. Suggestions to compare outputs included comparing the model with concentrations measured at Conowingo Dam, since they should be limited by concentrations that come over the dam. It may also be helpful to only compare output on days where there exist observed values and do a 1:1 paired analysis, and then overlay that with a 1:1 analysis of WSM outputs and the observed measurements at Conowingo.
- The purpose of the model is to answer questions regarding how nitrogen and phosphorus limitation change, and how that change affects DO. Plotting limitation, as a function for concentration to limitation, for both simulated and observed may help point to hits and misses that should be paid attention to more. This better aligns with the purpose of the TMDL and avoids the pitfall of focusing in on extremely high values between the model and observations.
- Currently there is no wetlands function within the model, and including that function necessitates thought about potentially emergent vegetation in the wetlands. As vegetation die, some will fall in place, and some may move out to the water column and decompose. This suggests that there may be a vegetation load to the open water, but this is difficult to know, or reach consensus on around the TMDL timeframe.
- Also noted was a sag in levels of DO on the lower York River, which is tremendously wide. However, simply subtracting oxygen from the shoreline does not produce the observed sag in the middle of the river. There was discussion regarding whether or not this may be due to marshes acting as a loading source, or if something else is being missed.

- Breaking apart TSS into silt and clay is difficult, as very few data stations provide such information. Because so few observation stations also report data on this differentiation, the split is not at all used in the calibration. However, there will be more information available from the Conowingo monitoring project, part of which is studying particle sizes during high flow events.

Refinements to the WQSTM Shallow Water Simulation – Carl Cerco, U.S. CoE ERDC
Attachment J.1, *Attachment J.2*

- Carl presented progress made in developing an improved representation of shallow water in the WQSTM.
- Six systems of focus were selected to obtain a wide-ranging and representative sample of classic embayments and rivers around the Chesapeake, which are outlined within the presentation.
- What kind of scale is needed for effective simulation in shallow water systems is being asked by the members of the shallow water modeling efforts. Addressing scale and individual tributary differences may also be part of the path moving forward.

Loss of Coastal Marshes to Sea Level Rise – Molly Mitchell, VIMS – Jeff Cornwell, UMCES
Attachment K

- Molly Mitchell described a survey and analysis of wetland loss due to sea level rise in the Chesapeake.
- The research presented suggests that a management push towards promoting living shoreline solutions that can migrate inwards, rather than shoreline stabilization efforts, may be much more effective. Fringe marshes cannot migrate, and are essentially the connectivity along the river.
- Different types of marshes respond very differently to accretion rates and other factors, and is an important consideration for modeling efforts.
- The approach taken that simply and immediately adds a half meter of SLR could be considered fair because fringe marshes cannot accrete sediment that rapidly and are not that dynamic, and will likely disappear with such an increase in water level.
- An approach suggested as a potential solution would involve comparing the differences in elevation the two surveys to just specify the changes. We'd be able to compare a simple bathtub approach with its annual loss to the annual loss measured. It would be interesting to compare a hindcasted model against historical records.
    - One issue is that six inches of SLR recorded to date is within the error of LIDAR data.
- Jeff Cornwell described planned work in laboratory experiments to analyze the composition and reactivity of organic nutrient material associated with marsh erosion and loss due to sea level rise
- The role of marshes in accreting and capturing nutrient species was discussed.
    - Marshes are taking about a third of nitrogen in the upper Patuxent River. Long term sinks of nitrogen and other material that have been building up over time are developed by burying organic matter.
    - Phosphorus also gets buried in organic matter, but points where the greatest accretion of phosphorus is occurring tends to align with points where inorganic materials are found.
    - There can exist significant differences within a single marsh among the nutrient species that are buried and where they are buried.
- As materials are eroded away, the reactivity of the materials is not fully understood.
    - In the past, the approach has been do as much as chemical analysis of materials as you can. This approach may not be helpful in terms of feeding data into models.
    - An approach that may be more helpful, and what was used in the research, is an examination of different categories of wetlands.

- As salinity intrudes, there is the potential for wetland plant loss during the transition with changes in the biogeochemistry and therefore alterations in burial and what occurs with the chemical species.
- A suggestion was put forth to examine the changes present in different types of marsh under both aerobic and anaerobic conditions.
- There is a program under on schedule to begin this fall which would study samples in decomposition experiments, and add the findings to wetlands modeling efforts in accordance with the 2017 timeframe.

Wetlands as a Phase 6 Land Use – Pam Mason, VIMS
Attachment L

- The Wetlands Expert Panel presented progress on working towards a consensus on recommended wetland types for application in the Phase 6 Model as well as methods for determining their loading rates.
    - An extensive literature review has been completed by TetraTech, and discussion has also continued regarding first order kinetic equations and their usefulness with available NWI data.
    - Heretofore, wetlands have not been included in the model.
- While the discretization of wetlands into the specific categories presented may not be possible, it may be achievable to break wetlands into tidal versus non-tidal and other broad categories.
- The goal of the efforts is to first develop wetlands efficiencies and loads, and then concentrate on the developing wetland BMP data.
- Pam also discussed the development of the kinetic equations to be used for wetlands.
    - Efforts began by simply plotting a best-fit regression line through a cloud of data that contained various types of wetlands in numerous settings from widely varying locations throughout North America and Europe. This line was meant to relate a percent reduction based on a ratio of wetland area to watershed area.
        - This is a very coarse approach, and discussions have been held regarding its limitations. However, there is not a tremendous amount of data to separate out and utilize the wetlands classification system.
        - It is known that storage is ultimately the way that the transformations occur. Kinetic equations can therefore be used as a surrogate for storage and considered to be a sort of starting point.
    - It was then asked if the base could be developed to act as modifiers, because it is known that wetlands with variable water tables will likely be the most efficient in some of the outlined nutrient transformations.
        - It may be possible at a higher classification to modify the kinetic equations for certain settings utilizing GIS.
- It may be possible to feed forest buffers and wetland efficiencies in the NHD catchment network through SPARROW to tease out relative contributions of these variables and their potential effects of land to water delivery within the model. This could then be refined by the Wetlands WG and the Wetlands Expert Panel later in 2015.
- What can be used as a default for the WQSTM while there is a waiting period for the expert panel to refine findings?
    - This is problematic because shoreline erosion is based just on tidal marshes, and our knowledge was about saline and brackish marshes is based on how lower Spartina marshes operate and may have some of the highest efficiencies. Tidal wetlands have an ability to treat water in situ, and are not just receiving overland flow.

    - It may be better to apply the tidal wetland in tidal context but not in the freshwater context. It would be likely to overstate the kind of attenuation
    - It may also be helpful to break down the classification as bogs and marshes to keep the two wetland types separate.
        - Data is available for the tidal wetlands, and an additional reduction cannot be added because what data has been produced through SPARROW is already the complete reduction that the watershed applies to those edge of stream loads. Anytime a reduction is added, double counting is occurring with something that has already been included in the SPARROW factors that and therefore something must also be subtracted.
        - If implementing wetland kinetic equations produces a better fit, then that can be included in the overall land to water delivery, but it cannot be added on to all that's in place.
- It may be best to develop an aggregate estuarine brackish marsh value along with some range.
- Hesitation was expressed by Carl Cerco to do anything in the WQSTM regarding tidal marshes.
    - There is an issue of splitting out constant wetland functions with periodic load attenuation.
    - There was discussion regarding avoiding the representation of any tidal wetlands within the WSM to avoid issues in differentiating the effects of the attenuation functions. It may be very problematic to divide the representation between the two models.
- Area is of the utmost importance in the WSM, while the emphasis of the WQSTM is volume and load. Essentially, the shoreline does not have to be so exact as long as the volume is controlled. Sinks and sources must also be well accounted for.

Meeting Attendance

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