PHASE 7 Activities

Variable scale modeling - Scale can be variable to support different needs

WQGIT	Decide on Scales	Q1 2022
CBPO Modeling team	Build model structure (calCAST)	2022-2023
MWG	Guide Modeling team	2022-2023
CBPO CAST team	Revise CAST for P7 scale	2025

- ❖ Please note that we are making a change in nomenclature for this activity. In previous meetings and in the Menti results we used the term "fine scale modeling". We are changing that to "variable scale modeling" to better represent what is intended.

Description

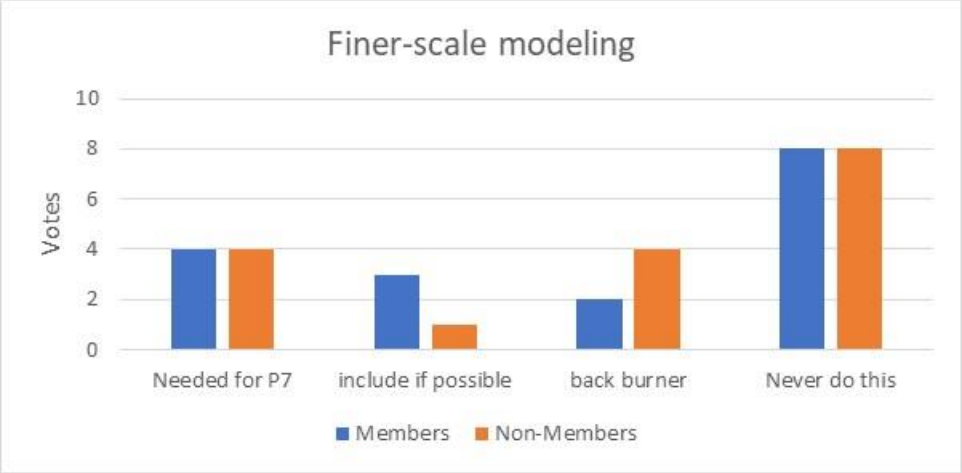
Data used in the phase 6 model are available on a variety of scales, 10-meter grid, NHD catchment, 5km grid, land-river segment, county, state, and even CB-watershed. Phase 6 CAST upscaled and downscaled these data sets to produce output at the land-river segment. Discussions with the CBP partnership have made it clear that there are different scales that are important for various uses. A modeling system can be devised that will run consistently at multiple scales.

The modeling team, under the guidance of the Modeling Workgroup, will build the model development structure (calCAST) during calendar year 2022 that will be used as the basis for Phase 7 development. This question will need to be settled in the near term for the modeling team to progress. The CAST team and optimization team, working with the WQGIT, will incorporate these scales into CAST in time for review in 2026.

The partnership answers to the following questions will determine the scale of Phase 7 CAST.

- For TMDL accounting purposes, what scale would you want for reporting BMPs and receiving credit based on location?
- Do you support the opportunity for receiving results at a finer scale that approximate the official results?
- What scale will you use for optimization?
    - How long will you wait for an optimization run?
- What scale of output do we need for the estuarine model? (CBPO recommendation NHD)

Initial discussion indicates that there are mixed opinions on small watershed scale modeling and that there is little support for field scale resolution.



Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- A simulation option made available for finer scale assessment in the watershed and in the tidal Bay so that all watershed streams and the tidal tributaries and embayments can be simulated
- If accurate, it will help state and local stakeholders and decisionmakers implement cost efficient and environmentally effective practices.
- of the ag lands in the watershed, identifying and targeting areas that are ripe for BMPs to produce a disproportionate load reduction.
- Targeting with implementation
- Optimal Land Use distribution for watersheds based on land cover and surrounding watersheds and existing use
- Being able to re-define/model local land use could direct to watershed optimal land use distribution and integration with surrounding watersheds
- Recognition of spatial limitations based on uncertainties
- Unless we can spatially capture landowner willingness, let's not spend significant staff and financial resources on targeting
- Refined scales or targeting is of little use to most localities; reality is that stormwater BMPs are sited by MS4 localities based on availability of sites and costs and by developers based on economics and regulatory requirements
- Tools should be used for state WIP implementation, tracking and assessment, not overly refined at small spatial scales
- Expand calibration points particularly in high loading areas

Physical process simulation

CBPO Modeling team	Average Loads and Sensitivities	2022-2023
CBPO Modeling Team	Physical Transport	2024-2025
MWG	Guide Modeling team	2022-2025
Ag Modeling Sub.	Load differentiation within Ag	2022-2025
Forestry Workgroup	Harvested Forest Loads	2022-2025
Wetlands Workgroup	Wetland loads	2022-2025

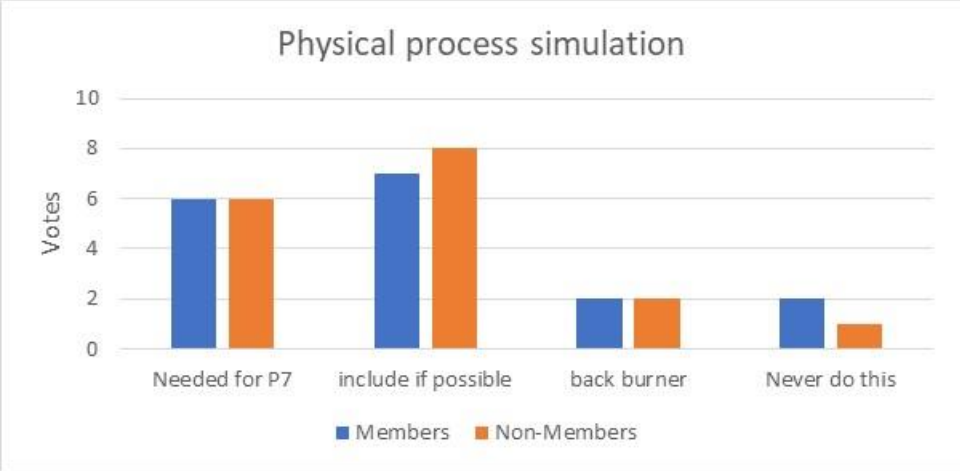
Description

The accuracy of the watershed model relies on the quality of estimates for the factors that are used to calculate loads and the processes simulated in those factors. The 2018 STAC workshop on the future of CBP modeling and the Phase 6 model review provided many opportunities for improvement.

Physical process improvement was a high priority for the WQGIT with many comments focusing on the need to bring in additional monitoring and monitoring-based studies to better characterize the average loads from urban areas compared with other land uses and the response of the loads to changes in inputs. Additional work on streams, wetlands, harvested forests, and solar fields will be emphasized. Transport processes including lag time estimates and nutrient speciation were also highlighted.

The modeling team will begin working on average loads and sensitivities in the third quarter of 2022 and continue through 2023. Physical transport will be a focus in 2024, potentially using new geomorphometry data delivered in 2023. Progress will be discussed in the Modeling Workgroup.

Differentiation between land uses within a sector is typically handled by sector workgroups. Harvested forest and wetland load relative to true forest and other natural landscapes will be discussed in those workgroups.



Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- More data for calibration in the watershed model
- Water quality monitoring and assessment of usage of data that is not currently being used
- Still lack of data from tidal/ coastal plain, need to incorporate monitoring efforts
- Need to incorporate more local tidal water monitoring data rather than extrapolate all loading assumptions from nontidal areas
- Use of local water quality monitoring data
- Urban load refinements, incorporation of local monitoring data
- More details on how urban loads and nutrient sensitivity will be revised
- Ag and urban load rebalancing
- Take another look at average source sector loads using more recent SPARROW and other loading information. Average loads should reflect more current conditions
- Improvement in urban phosphorus sensitivities to nutrient inputs
- Better P dynamics in urban watersheds
- Artificial increases in ag loads in multi-cropping systems should be evaluated

- Non-point source responses
- improvement to stream bed and bank loads
- Capture nutrient load from solar farm conversions
- Nutrient speciation
- Improved nutrient speciation towards a mass balance
- Ability to simulate BMP effectiveness spatially
- Groundwater loads quantified as a source
- Enhanced groundwater functionality
- Estimated lag times based on BMP mix
- Need to verify lag time assumptions in model with monitoring data
- Include groundwater loads as a separate load source
- Better definition of wetlands, of their hydrologic and biogeochemical cycling trends (including forms of N, P, and C)
- Still unclear how monitoring influences delivery factors and how those will be updated
- More explicit consideration of air sources, and how management factors influence these; providing more specific information as to how various management efforts might influence these loads.
- Apply nutrient speciation as with Conowingo
- Improve stream loads simulation. Separate natural and anthropogenic
- Improve simulation of sediment
- Reassess sector load splits

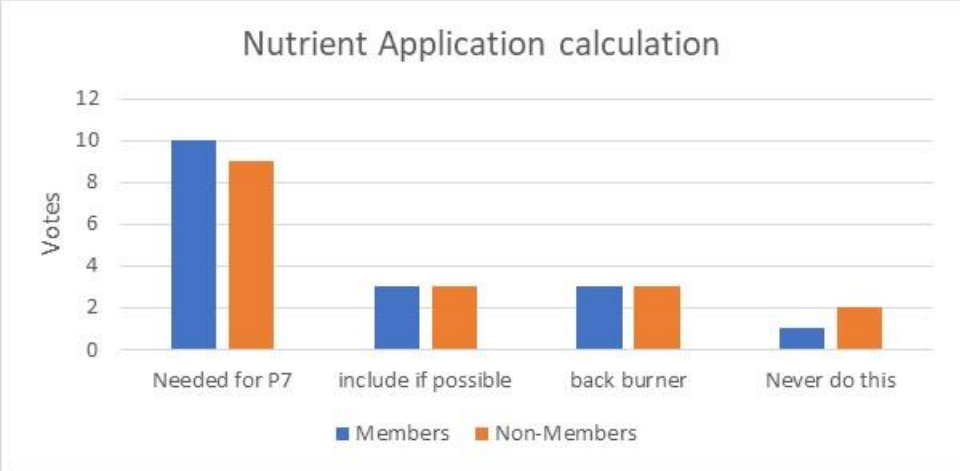
Nutrient Application calculation

Ag Modeling Subcommittee	Revisit nutrient inputs	2022-2025
CBPO Nutrient Team	Coordinate and support AMS	2022-2025

Description

During the formulation of the Phase 6 watershed model, the WQGIT and the agricultural stakeholder community in particular articulated that they wanted the model to be understandable and transparent. The simple structure of the Phase 6 CAST had the intended benefit of transparency to users. However, in the drive to include the combined knowledge of the Agricultural Modeling Subcommittee and to recreate processes in the model that reflected reality, a highly complex model of nutrient application was created. Currently, changes to the Phase 6 inputs have ripple effects in other land uses and areas of the watershed which are sometimes counter intuitive.

Nutrient application calculation change was a very high priority for the WQGIT with the clear direction that the model should produce transparent, intuitive, and understandable results to input changes. There was some discussion as to whether it should be built on the basis of Phase 6 or completely overhauled. In either case, the nutrient applications calculation will be the work of a re-constituted Agricultural Modeling Subcommittee. The work can continue through the review period of 2026, but should begin in 2022 so that draft data can be tested in beta model versions in the 2023-2025 period.



Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- Refine agricultural inputs for watershed model and CAST
- Refine nutrient assumptions in watershed model and CAST
- Find additional data sources to support agricultural simulation
- Simplify nutrient application calculation
- Simplification of agricultural model. It is too complex and leads to weird results
- More transparency (in terms of simplicity), user understanding of how simulation is being done
- Ag input refinements with new data sources
- Ag input refinements
- Manure/fertilizer applications, ag data inputs, application/model assumptions
- Improved agricultural data, looking to additional data sources beyond ag census
- Legume Assumptions
- Working from the Phase 6 base, perhaps an effort to re-evaluate application curves N fixation, soil P, land use/crop types, land use loading rates, fertilizer accounting, etc.
- Better urban fertilizer data
- Artificial increases in ag loads in multi-cropping systems should be evaluated
- Comparing year to year scenarios is very challenging because inputs (or understanding of inputs change). For instance, ag census data causes years that follow each other to appear significantly different, for reasons unrelated to progress.
- Transparency of input data sources and robustness, consistency, and similar metadata
- Improve Animal population estimates
- Improve nutrient application assumptions (urban and Ag)
- Reduce cropland load sources (current complexity adds uncertainty but little value)
- Improve Soil P data and simulation

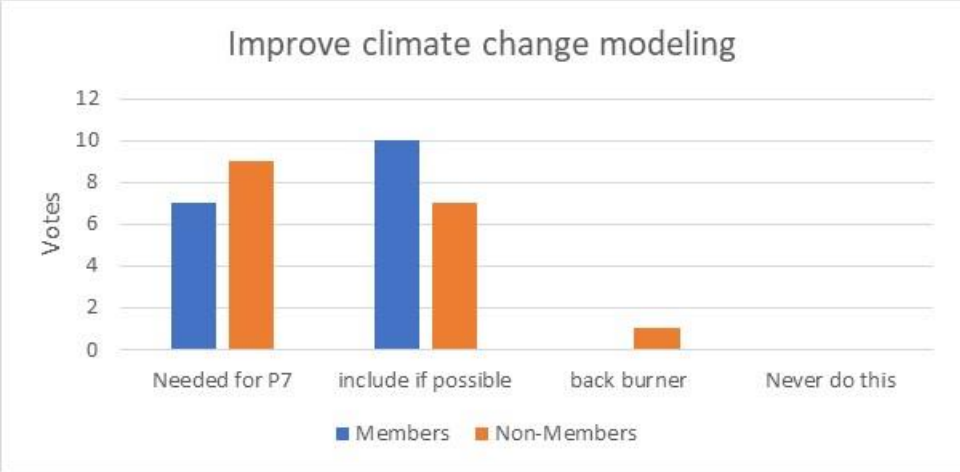
Improve climate change modeling

CRWG	Continue work on BMP climate effects	2022-2026
CBPO Modeling team	Estimate climate inputs	2026
CBPO Modeling team	Estimate climate effects on delivery	2026

MWG	Keep up to date on CRWG and Modeling Team	2022-2026

Description

The PSC has asked for improvements in the climate simulation in the models and the WQGIT identified improvements as a high priority, although few details were identified in the October 2021 meeting. For the watershed model, the major points of emphasis were the method of calculating the climate effect on precipitation and temperature and the effect of climate change on BMPs. Both effects are areas of active research and information that is not available now will be published in a few years when we make our assessment. Climate change assessment is not part of model development, rather it is a scenario that is run after development. Therefore, climate effects can be handled by the Modeling Workgroup and Climate Resiliency Workgroup in 2026, after model development. The estuarine model needs a significant upgrade to assess climate change effects in the shallows, which is covered under the heading 'Main Bay and Tributary Models'



Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- Need to address the PSC and EC direction on 2035 climate change assessment
- Changes to ag production resulting from CC
- Improve seasonality of climatological parameters

Main Bay Model (MBM) and Multiple Tributary Models (MTMs) – See attached detailed task chart for this activity

The Main Bay Model (MBM) is a state-of-the-science unstructured grid model of the Chesapeake tidal waters of the Bay, its tributaries, and embayments. The MBM is replacing the national award-winning Bay Model that has been successfully used by the CBP for three decades.

The management purpose of the MBM is to assess the Chesapeake Bay TMDL water quality standards of dissolved oxygen, chlorophyll *a*, suspended solids, water clarity, and SAV under conditions of climate change in 2035 and beyond. The MBM scenarios, as directed by Chesapeake Bay decision-makers, will provide support for management strategies to achieve living, resource-based water quality standards in the tidal Chesapeake Bay. Over the course of the six-year project, the four years (2022-2025) will be for model development and the final two years will be used for an full year review in 2026 and 2027 will be for model application, scenario development and analysis as directed by CBP decision-makers for nutrient and sediment

targets needed to achieve water quality standards and the Chesapeake restoration goals under 2035 climate change conditions.

Over the course of the project, the Multiple Tributary Model (MTM) teams (if funded in 2022 under a separate RFA) will develop and apply fine-scale tributary models using common forcing conditions, model state variables, and decision rules as the MBM in order to better represent Bay tributaries and shallow-water processes under future climate change conditions. The MBM team will collaborate and coordinate with the MTM teams on a regular basis over the project period.

Menti Responses

- MBM – improve shallow water simulation for CC, improving problem tribs and incremental attainment.
- SAV nutrient sinks simulation.
- Living resources interactions.
- A simulation option made available for finer scale assessment in the watershed and in the tidal Bay so that all watershed streams and the tidal tributaries and embayments can be simulated.
- Improvements in shallow water modeling (estuarine model).
- Simulating dynamics in shallow water.
- Focus on shallow waters modeling in part because they introduce significant uncertainty that modeling could help flesh out a little bit more. Focus on shallow waters also readily engages stakeholders, including mobilization of resources.
- Need models that would allow the assessment of different water uses (for example cold water and small embayments) and to show progress at the scales where progress has been made.
- Focus on progress that can be made in shallow waters.
- Improve shallow water dynamics.
- Greater connection of modeling to shallow waters and living resources.
- Improve simulation of temperature and DO in shallow open water.
- Improve resolution of grid to better estimate climate change effects.
- Improve seasonality of climatological parameters.
- Improve simulation of "problem tributaries".
- Develop tributary specific sub-models.
- Improve wind driven dynamics.
- Add ability to model incremental progress, attainment in individual segments and uses.
- Improve nutrient speciation simulation
- Add ability for model to estimate WQ response based on different conditions.
- Re-assess Sediment TMDL based on clarity.
- Wait on MTMs.
- MTMs should wait

High Resolution Land Use in Phase 7

The high-resolution land use and land use change data and land use forecasting capabilities are being developed independent of CAST and Phase 7. It is the intention of the LUWG to change the methodology by which the high-resolution data inform the Phase 7 watershed model. This specific

methodology change can only be incorporated with a phase change of the watershed model. Other applications of the high-resolution land use data can be pursued and incorporated into the phase 6 model and Phase 6 versions of CAST. Activities related to high-resolution land use data are outlined in the next section.

ADDITIONAL ACTIVITIES -These can be pursued outside of a phase change

High Resolution Land Use phase 6 and non-CAST Products

Major Actors	Role	Timeframe
USGS Land Data Team	Maintain and enhance the Chesapeake Bay Land Change Model, develop historical backcasts of land use, provide technical oversight of, and assistance to, the CC and UVM, and solicit and coordinate input from CBP workgroups and GITs.	2019-2024
Chesapeake Conservancy and University of Vermont	Develop land cover, land cover change, land use, and land use change data for 2013/14, 2017/18, and 2021/22.	2018-2024
LUWG, FWG, AGWG, WWG, WQGIT, and HWGIT	Review methods and data and approve their use in CAST (WQGIT) and for the Land Use Methods and Metrics Outcome (HWGIT).	2021, 2024
EPA	Provide administrative oversight of the Cooperative Agreement between USEPA and the Chesapeake Conservancy.	2018-2024
State and county agencies and NGOs	Provide ancillary data to the CBPO for translating land cover into land use. Review and comment on draft data.	2020-2024

Description

The CBP requires accurate land use information to inform various outcomes in the 2014 Chesapeake Bay Agreement including water quality/TMDL management decisions. To inform these various outcomes, land use data are needed for historic (1985-2012), recent (2013/14 - 2021/22), and future time periods (2023 – 2055). The methods and input data used to create comparable land use data for these three periods are different and unique.

Note: while remote sensing technologies and methods for monitoring change in wetlands exist, such as side-aperture radar and hyper-spectral imagery, all would require special tasking and purchase of imagery and therefore are not proposed for the near future due to their cost. This is an active area of investigation by the Wetlands Workgroup. Improving the representation of non-tidal wetland functions for Phase 7 is desirable and was initially pursued for Phase 6. Assessing their hydrologic/water quality functions is complicated by the fact that most non-tidal wetlands spatially coincide with riparian forests or headwater ponds. Therefore, the challenge isn't necessarily better assessments of wetland functions, but better assessments of landscape functions based on spatial context.

Historic Land Use and Land Use Change (1985 – 2012)

The USGS Land Data Team (LDT) is developing historical land use data consistent with the 2017 high-resolution land use classification scheme at the tax parcel scale. High-resolution data do not exist for the historical period, but 30-meter resolution land cover/land use data derived from Landsat satellite imagery are available for this period from the USGS' Land Change Monitoring, Assessment, and Projection (LCMAP) Program (annual, 1985 – 2019), USGS'

National Land Cover Database (2001, 2004, 2006, 2008, 2011, 2013, 2016, 2019), and USDA's Cropland Data Layer (annual, 2008 – 2020). In addition, the US Census Bureau's Decennial Census provides data on population and housing at the Census Block Group scale (1990, 2000, 2010, and 2020). The LDT will integrate these data with 2017 land use and tax parcel data to infer historical land use conditions at the tax parcel scale. These data will be incorporated into Phase 7, not Phase 6, because the data will necessitate recalibration of the watershed model and subsequent revision the pollution reduction targets.

Recent Land Use and Land Use Change Data (2013/14 – 2021/22)

The USEPA entered into a Cooperative Agreement with the Chesapeake Conservancy (CC) in 2018 to produce high-resolution (1-meter) land use and land use change data for the years 2013/14, 2017/18, and 2021/22. Subsequently, the CC subcontracted with the University of Vermont's Spatial Analysis Laboratory to produce land cover and land cover change data for these years. With guidance from the LDT, the CC has developed a land use model to translate 12 land cover classes into 60 land use classes with the help of ancillary data. These classes are mapped consistency across all private, state, and federal lands in the watershed except for Aberdeen Proving Grounds for which NAIP imagery is unavailable. The USGS developed a separate land use change model to infer 2013/14 land uses from land cover change combined with the mapped 2017 land use. High-resolution land use change from 2013/14 to 2017/18 was incorporated into CAST-21 and will be incorporated into CAST-23. High-resolution land use change from 2017/18 to 2021/22 will be incorporated into CAST-25. The mapped, wall-to-wall, land use data for 2013/14, 2017/18, and 2021/22 will be incorporated into Phase 7 along with the revised historic land use data for 1985 – 2012. When used in Phase 7, the land use data will reflect a more detail classification (18-20 classes) including lands under construction, animal feeding spaces, and timber harvests. These classes are inferred or reported for the Phase 6 model, not mapped.

Future Land Use and Land Use Change Data (2021/22 - 2055)

The USGS developed the Chesapeake Bay Land Change Model (CBLCM) starting in the late 2000's. It has been reviewed by STAC twice, in 2008 and 2010, and is currently in its fifth generation and is undergoing peer review for publication in the Journal of the American Water Resources Association. This publication will improve transparency of the model and validation. The CBLCM v5 forecasts future development and land conservation at user-specified intervals (e.g., 2025, 2035, etc.) and it is parameterized based on historic land use change. For the Phase III WIPs, CAST-17, CAST-19, and CAST-21 impervious surface changes from 2001 – 2011 from the National Land Cover Database were used to parametrize the CBLCM. For CAST-25, the USGS will develop CBLCM v6 which will be parameterized based on high-resolution changes in development from 2013/14 to 2021/22 and able to simulate future timber harvests and the contraction/expansion of active agriculture. Note that the forecast period for CAST-25 is only 3-4 years (from 2021/22 to 2025) and therefore the CBLCM will have much less impact on progress estimates compared to previous versions of CAST with longer forecast periods. The CBLCM v6 will also be used to inform the Phase 7 model for forecasting land use change through the year 2035 and beyond.

Timeline

The 2021/22 high-resolution land use change data will be completed by February 2024 and used in CAST-25 (rolled up from 60 classes to the 13 Phase 6 classes). The wall-to-wall land used data for

2013/14, 2017/18, and 2021/22 will be used in the Phase 7 model (rolled up from 60 classes to 18-20 Phase 7 classes). Significant updates to the CBLCM based on the high-resolution data will be completed by May 2024 for use in both CAST-25 and Phase 7. The mapping of historical land use from 1985 to 2012 was initiated in 2021 by USGS and will be completed by February 2024 for use in Phase 7.

Comments from WQGIT Oct 25-26, 2021 (Menti responses)

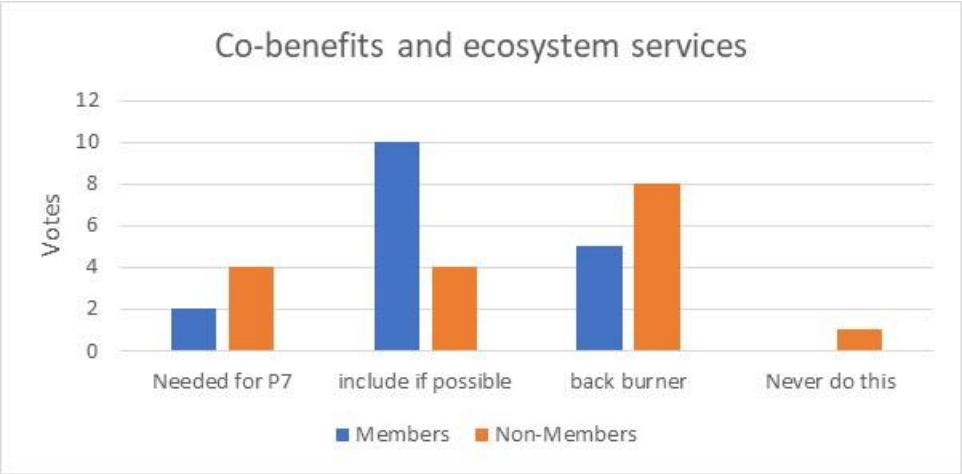
- Land Use Change Model
- Data that captures what forests and wetlands are lost
- Transparency in land use change model
- Better wetland data tracking
- Incorporation of Actual LU data vs. Change Product
- Improve representation and simulation of land use change (1985-2035)
- Better land use change estimates
- Updated LU mapping
- Incorporation of Actual LU data vs. Change Product
- Differentiate federal agency lands
- Differentiate state lands
- Better definition of wetlands, of their hydrologic and biogeochemical cycling trends (including forms of N, P, and C)
- Improvements to abandoned and historic mined lands
- Transparency in land use change model
- Refine land use change model beyond current urban growth model
- Add the land use model to CAST, tie land use change model in with tools, it's not transparent as is
- More understanding of land use change model, inputs, and assumptions
- Evaluate land use change over time and review land use policy BMPs based on the evaluation
- Forecast all LUs
- Supplement forecast to use 2013,2017 and 2021 LU change
- Supplement forecast to use Jurisdiction reported data
- Implement new wall to wall LU
- Improve Simulation of Harvested Forest
- Simulate agricultural feeding space
- Simulate all land uses on federal lands

Co-benefits and ecosystem services

All Goal Teams	Evaluation of BMP data and current capability to develop methodology for quantifying non-water quality benefits. Bring forward information on those benefits, including methodology, through the partnership for approval to incorporate into CAST	On-going
CAST Development Team	Incorporation of non-water quality benefits into CAST	On-going
GIS Team	Assistance with data visualization	On-going

Many Goal Team and workgroup members have expressed a desire to quantify non-water quality benefits and incorporate these co-benefits into CAST that result from implementation of BMPs. The primary objective of CAST is to evaluate management scenarios to achieve a desired water quality goal. Many BMPs that are implemented to achieve desired water quality results have additional benefits that can be quantified and incorporated into CAST. This would allow for those benefits to be shown as part of any CAST analysis.

These benefits can be included as part of any two-year update to CAST because they will not affect the underlying calculations, assumptions or data that affects the model calibration.- There are a number of benefit candidates that could be incorporated into CAST now. The partnership will need to decide on the appropriate approval process for incorporation of these benefits into CAST.



- Co-benefits!!!
- Incorporate co-benefits of each practice that can be selected by the user
- add co benefits sooner rather than later
- Tracking Bay Agreement outcomes, in addition to WQ progress
- Add all the 30 outcomes to CAST
- More local scale impacts
- Co-benefits – include carbon sequestration and soil carbon change resulting from a CAST scenario (Start from NRCS COMET model)
- Evaluating co-benefits (flooding, carbon, air quality, etc.) with NPS
- Address benefits to other outcomes, such as stream health, toxic contaminants
- Living resources interactions
- Accommodate PCBs and other pollutants
- Focus on BMPs with co-benefits to achieve multiple benefits
- Need models that would allow the assessment of different water uses (for example cold water and small embayments) and to show progress at the scales where progress has been made
- Quantify CO_2e and soil carbon for scenarios
- Add Soil C simulation
- Simulate plastic pollution
- Integrate flood susceptibility as driver of loads
- Support HAB analysis

BMP Optimization – See attached detailed task chart

The CBP BMP Optimization Project is working to develop and implement an optimization tool that will provide CBP decision makers an estimate of least cost solutions to nutrient and sediment reductions needed for the restoration of the Chesapeake watershed and tidal Bay. Over the course of six years (2020-2026), a state-of-the-science multi-objective optimization method will be developed to minimize cost and restrict nutrient and sediment loads anywhere in the Chesapeake watershed.

The work is comprised of two major activities: 1) Investigate, develop, program, verify, and implement an optimization system built around the CBP's CAST Model and 2) Provide expert oversight of and troubleshooting support to the CBP as a guidance and technical transfer support of the optimization products. The optimization will be provided to the CBP CAST users through a web based dashboard at County, State, Federal agency, or whole watershed scales.

- Provide a menu of options/BMPs for CBP decision makers to consider. The CBP Modeling Workgroup is actively working on this now going and it is an ongoing task throughout the CBP Optimization development.

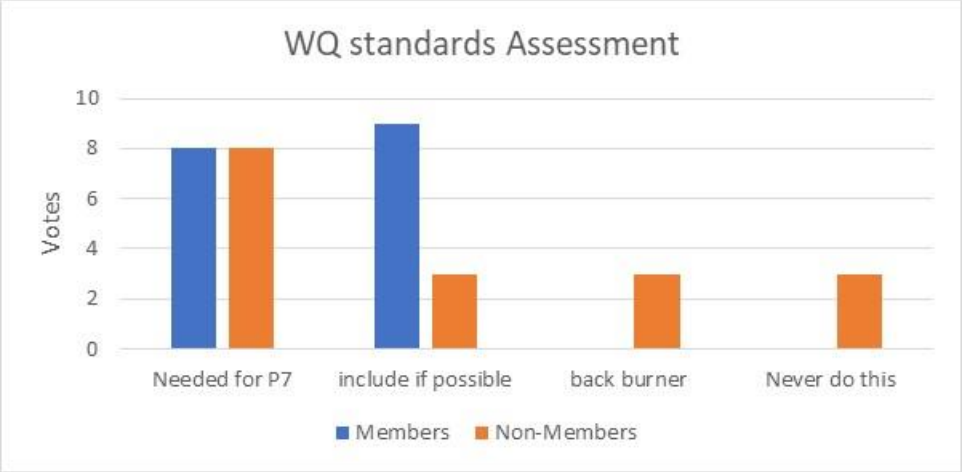
WQ standards Assessment

Bay Oxygen Research Group (BORG)	Development of new 4D water quality interpolator	2022-2025
CAP WG (and STAC and Fish GIT)	Evaluate current D.O. criteria – make recommendations for keeping/changing Develop quantitative CHLA criteria for regions of the bay where only narrative criteria apply Evaluate the viability for satellite-based resource assessments of CHLA and water clarity criteria	2022-2025 2022-2027 2022-2027
WQGIT	Evaluation of recommendations – 4D interpolator results	2026-2027
Hypoxia Collaborative (Fish GIT)	Sampling design and network development supporting water column habitat continuous monitoring.	2022-to-eternity
SAV WG (Habitat GIT)	Develop consistent protocol for satellite-data interpretation of SAV from imagery, develop AI/ML method of image assessments, integrate satellite-based SAV assessment as a gap filling strategy for the existing annual aerial SAV survey, calibrate historical aerial image assessments with satellite-based assessments as part of the evolution of the program for further satellite-based SAV monitoring. Integrate volunteer monitoring calibration protocols.	2022-2027
Chesapeake Monitoring Cooperative	Coordinate on subestuary monitoring program development supporting criteria assessment with data collections feeding 4D interpolator assessment of bay health, calibration of models	2022-2027

0 of 92 segments have ever been fully assessed with our existing investments in traditional monitoring and evaluation tools since the publishing of USEPA (2003) Chesapeake Bay criteria on dissolved oxygen, SAV/Water Clarity and Chlorophyll a that have subsequently been adopted into tidal bay jurisdictions water quality standards. Our current monitoring approach and the use of an Integrated Distance Weighting interpolation of water quality data to assess our current water quality criteria fall short of a complete evaluation. Development of a new 4D WQ interpolator will allow for the assessment of all dissolved oxygen criteria in all segments of the Bay. This tool will be completely separate from the P7 Estuarine model and will utilize monitoring data from our extensive network and planned additions of new continuous data collection sites.

As part of the development of this new tool, an assessment of spatial and temporal coverage of D.O., salinity and temperature monitoring will be conducted. As part of the evaluation of climate change impacts, current D.O. criteria will be evaluated to ensure that protection to resident important species is maintained and that we also re-evaluate the species that we need to protect.

Advances in monitoring options are occurring offering increased opportunity for integrating satellite-based imagery into water quality monitoring programs. As part of the evolving methods for water quality criteria assessment, satellite-based assessment of SAV and improved image translation efficiencies applying AI/ML-based algorithms are being developed. Advances in CHLA and Water Clarity assessment with satellites have occurred in research fields and are being evaluated for operationalizing with standard protocols for assessing and reporting. Volunteer monitoring assessments are further evolving to address data gaps and increasing their contribution to criteria assessment will continue to grow in the future.



Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- Being able to better assess water quality standards for all designated uses
- Ability to assess attainment.
- Add ability to model incremental progress, attainment in individual segments and uses
- The attainment of standards, which is based on monitoring, needs to be used for more strategic decision making.
- The focus in deep channel as a premise ignores shallows and we need a policy shift at the highest levels if we want to show progress where we have most interaction. With local waters
- Tidal monitoring data and progress toward attainment needs to be used more in the decision making for water-quality.
- Consider info provided to us from STAC – more effective implementation, rethink criteria…
- We need to invest more in monitoring and tweak the model. To serve more needs
- Additional monitoring efforts should be made
- Add ability to model incremental progress, attainment in individual segments and uses.

BMP Reporting Transparency

CAST Development Team	Determine solution and development plan for redesigning BMP submissions for WQ and other GIT outcomes that allows all data and data errors to be seen in CAST	2022-2025
WTWG and WQGIT	Review proposed solution, user acceptance testing	2022, 2025
EPA	Address issues related to the EPA grant money to states to support the development of the NPSBMP schema and setting up state nodes	2023-2024

Description

The Chesapeake Bay Program's CAST Development Team is investigating options for integrating NEIEN with CAST. This could include:

- Submitting progress data directly to an upload function in CAST available to specified users.
- Converting submitted data to CAST BMP names and units.
- Moving the submitted data (NEIEN) error report into a CAST report available for download for the progress scenarios.
- Moving invalid BMPs into the official annual progress scenarios. This would allow users to see all the invalid data in one place.
- Unify reports to limit the number of reports an analyst must review. Reports already in CAST show where a BMP was submitted in excess of the area available for the BMP.

Timeline

There are many elements that would require redesign to bring this vision to fruition and to provide an exact development plan for how this could work. The level of effort for this task is **HIGH**. The proposed changes ripple throughout several systems and require a new data structure. These changes touch an estimated 80% of the existing systems. The proposed goal can be met, however, there is a high level of complexity. The desired solution would maintain "backward compatibility" so that jurisdictions would be able to continue using establish reporting formats until such time that they are able to make changes to their automated data collection and reporting systems.

To meet these timeframes with the in-house team, there would need to be an almost exclusive focus on this (i.e., no other CAST/Point Source/other development). Otherwise, the timeframe is likely to be longer. However, the Data Center could try to engage external resources to potentially speed up development. This task should be woven into the broader work underway to develop a tracker of practices and efforts toward achieving other outcomes, such as wetlands and black ducks. This would allow for a more generalized data submission process for CBP that would include other types of data. This would allow consistency with our data reporting/submission mechanisms moving forward (so may include the water quality data/DUET).

1. Planning: 6-months
2. Development: 1-year
3. User Acceptance Testing : 6-months, or one annual progress submission and evaluation period

Comments from WQGIT Oct 25-26, 2021 (Menti Items)

- Improve transparency of NEIEN to CAST data reporting

- Publicly accessible tracking of BMP losses through verification and back-out and cut-off
- CAST transparency – ability to see all the reported BMPs, verification, backout, and cutoff in one report
- Integrate Progress Data reporting into CAST
- Improve submitted vs credited report to show all steps from state reported to credited
- Link annual reporting to CAST so we can see the date of implementation
- Get rid of NEIEN incorporate data reporting into CAST

Spatially Explicit CAST

GIS Modeling Expert Contractor	Deliver the information at any scale using the high-resolution land cover data	2022-2024
CAST Development Team	Integrate with CAST	2023-2024
Source Sector Workgroups, WTWG, and WQGIT	Review and revise proposed solution, user acceptance testing	2022, 2024

Description

The Spatially Explicit CAST topic is an upgrade to the interface that would deliver the information at any scale. Using the high-resolution land cover data in CAST is expected to remove uncertainties about data processing between the USGS-produced Land Data and the CAST land use data. This enhancement also will help CAST be understood and supported by partners and stakeholders with a wide range of technical knowledge, thereby expanding usage conservation project staff and farm advisors in rural areas. In addition, the enhancement will also negate the need for urban planners to convey their site-specific land use to the larger scale information currently available in CAST.

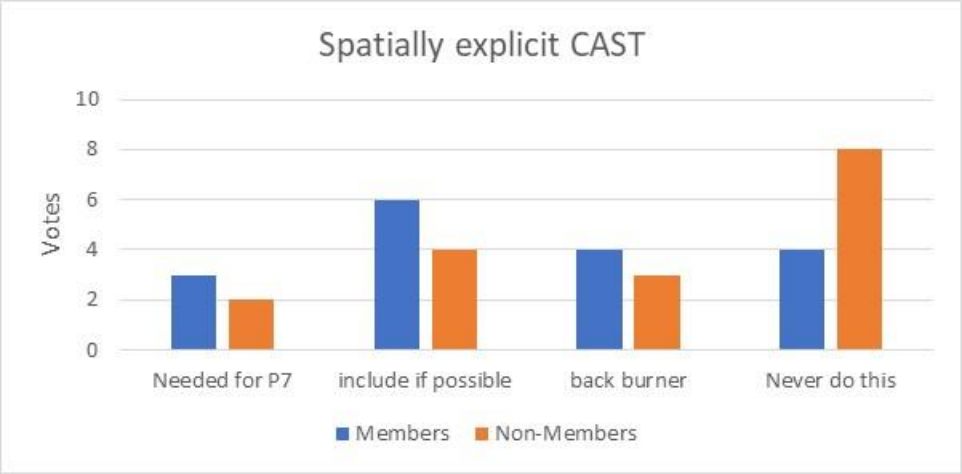
Restoration planning could be conducted on a site-specific and project-specific basis, and show the impact in the watersheds, tidal areas, and Bay segments. This would facilitate targeting BMPs to land uses that have the highest load and areas with the highest delivery to streams and the Bay.

Timeline

Once a contract is awarded to a team that has experience and knowledge about tiling GIS data in an on-line application, the timeframe is:

1. Development: 18-months
2. User Acceptance Testing : 3 to 6-months

Comments from WQGIT Oct 25-26, 2021 (Menti Items)



- A land use map would help partners to visaulize where BMPs could be targeted
- More flexibility to take advantage of higher resolution data
- More local scale impacts
- Land use change patterns
- Don't focus too much on being spatially explicit, scales are too different

CAST General

CAST Development Team	Determine solution and development plan for redesigning information and data, especially information available without logging in to run scenarios	2022-2026, released on an ongoing basis as completed and approved
Source Sector WGs, WTWG, WQGIT, all other GIT leaders	Review proposed solution, user acceptance testing	2022-2026

Description

Multiple items were raised that are already incorporated into CAST. Since there were requests for items that are already available, it is evident that ease of access, documentation, and trainings need to be enhanced. Improvements to the BMP cost data and clearer documentation also were requested. Some new functionality was raised, including:

- Multiple climate change scenarios
- Modeling ammonia differently
- Centralizing all web-available modeling into CAST

The change in how ammonia is modeled should be addressed in Phase 7. All other items can be accomplished by modifying the existing CAST framework. A robust approach for incorporating these changes is to wholistically redesign the sites navigation and add additional functionality in a planned way, rather than tacking it on to existing pages and options.

Timeline

1. Planning: 6 - 12 months
2. Development: 18 months

3. User Acceptance Testing and Revisions: 6 months

Comments from WQGIT Oct 25-26, 2021 (Menti Items)

Existing Functionality Improvements and Clarifications

- Differentiate federal agency lands
- Differentiate state lands
- Ability to simulate BMP effectiveness spatially
- Ability to see percent of load reduction from each BMP type when building a scenario (e.g., forest buffers account for x% of load reductions in scenario)
- Progress scenarios should make clear what changes due to management (BMPs, investments, etc.) and what changes due to growing pressures (growth, animals, climate)
- Improved cost estimates
- Improved cost estimates with NRCS tie in
- Ensure backward compatibility

Documentation Improvements

- Determining the benefit of specific efforts and weighing them against others is not simple
- The connection between air sources and management efforts is very unclear, particularly on the ammonia side
- Model documentation that allows users to easily track how Phase 6 (or the new Phase) functions
- Better means of communication to stakeholders about modeling processes and results
- Improved documentation on the website
- Whatever we do, communication of the strengths, weaknesses, applicability of tools need to be better communicated to the public
- Scales for each input and output should be available
- We need to provide better context on utility of the model to policy makers using the model to make decisions.
- Consideration of how practices and decisions are applied as offsets/trades to account for growth

New Functionality

- Ability to run different climate change scenarios
- Add ability for model to estimate loads based on variable hydro
- More explicit consideration of air sources, and how management factors influence these; providing more specific information as to how various management efforts might influence these loads.
- Specific consideration of how to manage air sources within the modeling framework (and make it clear to the managers/CAST users of the air implications of inputs or BMPs)
- Build on Bay Data Dashboard, tributary reports, land use data, and Chesapeake Conservancy BMP opportunities work to aggregate those products into a BMP targeting tool
- Build BMP targeting tool outside (but linked in) CAST. Use bay data dashboard, tributary reports, land use and CC BMP opportunities work as a starting point
- We need a way to merge our tools so mapping and CAST are mutually supportive
- Integrate GIS layers, EJ Screen, Data Dashboard, and Chrissie Bibi and healthy watersheds assessment into one place (CAST)

- Centralized location for all web-available modeling tools
- Integrate with Data Dashboard and Tributary Reports to help guide actions/management

WQGIT general

WQGIT with input from workgroups, advisory committees	Revise BMP Review Protocol	2022
WQGIT and Workgroup Chairs/Coordinators	Workgroup and WQGIT leadership to consider how to refine or incorporate requested items in their calendars/workplans if desired	2022
Source Sector WGs, WTWG, WQGIT	Based on consideration of items, address specific actions as appropriate	TBD

Description

Multiple items were raised that called for the WQGIT and its workgroups to consider options to improve assessment of BMPs (new or existing); BMP tracking, accounting or verification; program evaluation; process changes. Some workgroups already have ongoing discussions about such issues, or plan to have them in the future. For many of the items raised under those four categories, the WQGIT and workgroups will require further input or specific discussions to further articulate the requests so they can then determine if time and resources are warranted given their respective calendars, workplans or priorities.

The WQGIT is revising the BMP Review Protocol, which will update the review process for new/proposed BMPs as well as a streamlined process for workgroups to consider clarifying existing BMPs as needed.

Most other suggestions will require further clarification and a determination of whether to proceed by the WQGIT or appropriate workgroup. This will demand that interested partners, including those who made the suggestions in October, elaborate on the suggestions in order to create either (1) specific action items, or (2) valuable information-sharing or discussion topics that could generate specific actions, produce beneficial collaborations, or reap educational value for participants. The latter may simply need discussion forums at workgroups or in partnership-sponsored environments. In other words, they are more about information-sharing and may not be associated with specific deliverables or changes within partnership tools, products or outcomes. Granted, the information-sharing, collaboration and subsequent discussion forums of these items could generate recommendations or requests for action within the partnership, which could be added to future workplans.

Timeline

1. For BMP Review Protocol revisions: flexible timeline to be completed Q1/Q2 2022 at the earliest
2. For additional requests:
    a. Planning: over course of 2022 based on WQGIT's and workgroups' ability to refine the items into specific actions or discussion forums as appropriate
    b. Actions: TBD

Comments from WQGIT Oct 25-26, 2021 (Menti Items)

BMPs: Assessment of new BMPs or revisiting established BMPs

- Improved and simplified processes to capture and credit existing BMPs, especially those related to BMPs for nonpoint pollution control
- ensuring BMP efficiencies are fully evaluated that have been introduced in CBPO workgroups
- Update accounting for air credits, how to take credits from air actions beyond what is required by the Clean Air Act

BMPs: tracking, accounting or verification

- Identifying new approaches to verification that avoid utilizing critical technical assistance staff time
- Tools that prevent technical assistance staff from focusing on verifying rather than implementing
- Further assessment of uncredited BMPs
- Means of encouraging reporting and crediting of agricultural BMPs
- Easier stream restoration crediting
- A better way to track annual BMP implementation progress without the issues that currently arise due to BMP expiration (e.g.: verification)
- Investing in tracking tools (satellite imagery, fertilizer data, etc.) that avoid the need for onsite verification and will last for decades to come

Program evaluation

- More explicit modeling of the incentive programs in place (particularly for ag) and how they have influence implementation
- Explicit considerations of incentive programs and how those programs look according to CAST
- Greater understanding, incorporation, and public outreach of fiscal and financial impacts of model effects on land management and conservation practices
- Evaluate what's working and what's not
- Focused attention on subject areas where implementation has been limited
- Greater opportunities to evaluate trade-offs
- Need evaluation of what commitments we fell short of and why
- Cost share programs around the watershed are built around the idea that they get credit in the bay model; yet I don't think there has ever been an alignment between these systems – and more explicit connections could be greatly beneficial

Process

- Faster updating of progress scenarios
- More time for WTWG and source sector workgroup review
- Moving into 2025 with a stable model to support regulatory stability
- Continued evaluation and application of Ag BMPs and methods being considered by the AgWG and BMP verification Ad hoc Action Team

Uncertainty Quantification

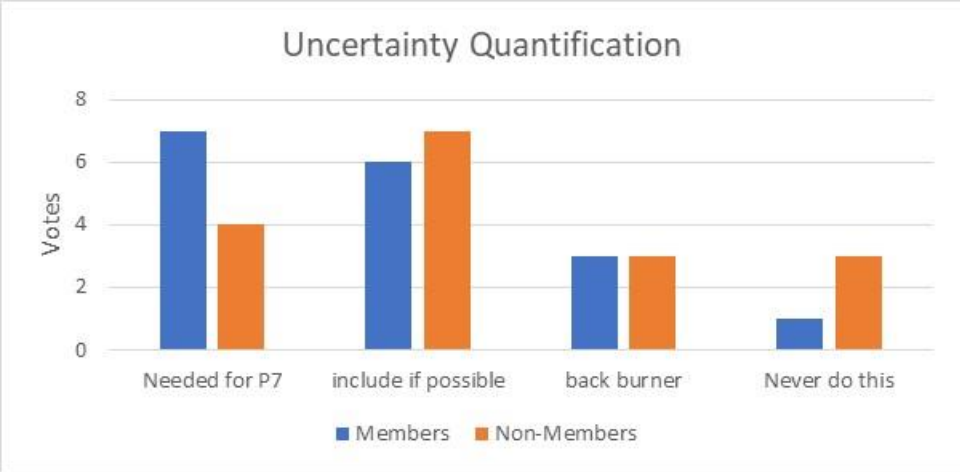
WQGIT	Estimate uncertainty of BMP effects and implementation	2022-2025
AMS	Estimate uncertainty of inputs	2022-2025
CBPO Nutrient team	Support AMS	2022-2025
CBPO Modeling team	Estimate uncertainty of transport and loads	2022-2025
CBPO Modeling team	Continue work on inverse quantification	2022-2026
MWG	Keep up to date on WQGIT and Modeling Team	2022-2026

Description

Broadly speaking, there are two methods of estimating uncertainty – forward propagation and inverse quantification. Forward propagation involves starting with the uncertainty of the individual inputs and processes in a model and then running the model many times to estimate the uncertainty of the combined system. Inverse quantification involves statistical comparison of the model output with observed data to see how close the model comes to the data.

The WQGIT was had mixed voting but was generally in favor of uncertainty quantification. Comments tended to cluster around expressing the uncertainty of inputs (a feature of forward propagation) and comparisons with monitoring data (inverse quantification). The Modeling Workgroup has been discussing a draft inverse quantification of Phase 6 predictions for the past several quarters and this work will continue. The structure of phase 7 will likely enhance the ability to make these comparisons.

Quantification of the uncertainty of inputs will exists for some phase 7 inputs, but not for all without additional work. The modeling team can likely provide uncertainty of physical transport factors, loading rates, and sensitivities. Other providers of inputs, such as the Agricultural Modeling Subcommittee, states submitting BMPs and wastewater data, and BMP panels will have to calculate uncertainties of their supplied data sets for a full assessment.



Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- Characterization and articulation of uncertainty
- Some assessment of uncertainty could be beneficial
- Addressing uncertainty
- More transparent about uncertainty
- Modeling monitoring comparisons available

- There is progress to be made to match model input/ outputs to what we are seeing in on the ground implemetnation and monitoring
- Relative confidence of inputs distinct by source sector with outputs
- Relative confidence of estimated loads as an output metric, even qualitative like high or low
- Include confidence and uncertainty metrics among the various parameters
- Qualitative estimates of confidence based on BMP mixes and land uses inherent to geographies and scenarios
- Compare Phase 6 or 7 with other models, such as SPARROW, specifically future climate impacts on water quality
- Recognition that uncertainties cannot be eliminated completely, that the best way to handle uncertainty is to be transparent about it
- Evaluating if we need to look at uncertainty using different approaches

Phase 7 Planning Targets

WQGIT	Remain aware of general methods	2022-2025
WQGIT	Make decisions regarding new planning targets	2026-2028
CBPO Teams	Support with model runs	2026-2028

Description

The modeling workplan will be well-served by envisioning the final use of the models to generate new planning targets. The partnership will likely consider new modeling results, new standards assessments, updated climate change data and processes, additional research on Conowingo, and consideration of the calculation methods for planning targets. These topics were not part of the workplan discussion, but the WQGIT generated comments that will be useful going forward. Potentially, the WQGIT could briefly discuss the upcoming assessment each year 2022-2025 and then use the years 2026-2028 to make the decisions that will guide the partnership for the following period.

Comments from WQGIT Oct 25-26, 2021 (Menti responses)

- The focus in deep channel as a premise ignores shallows and we need a policy shift at the highest levels if we want to show progress where we have most interaction. With local waters
- Efforts, which have important influences on bay tributaries, but limited effect upon the most sensitive segment are not “rewarded” in CAST
- Future modeling should not simply tweak what we are doing and already know. Instead, test our underlying assumptions (deep channel goal) and how the changing world/watershed is going to impact our efforts and what we may need to do to adapt efforts.
- We need to step back and reconsider the big picture questions we want the models to help answer
- Focus on progress that can be made in shallow waters
- Consider info provided to us from STAC – more effective implementation, rethink criteria…
- Update critical conditions period and 10-year hydrology period
- Reassess and Update critical period
- Average Hydro Update
- Reassess E3
- Develop EP (extent practicable)

Comments, mainly from 'Key Takeaways' and 'did the presentations change anything' questions

- We have made a lot of progress but there is still work to do
- It is an evolving process and the program is assessing how to best utilize existing monitoring data
- Modeling is an iterative and nuanced process
- There is still the influence of policy decision making in determining states' respons to modeling
- Have the prior 8 model updates improved the partnerships ability to plan/ target implementation?
- Opportunities exist for improvement. We have a long, accalimed histort of leading edge model development.
- We are making steady progress, one step at a time.
- The modeling tools have made significant progress over time, however there are still gaps that should be addressed in order for the model to be more informative toward planning and assessing performance
- We need lead time to communicate changes in load targets to leadership.
- Monitoring may affirm the accuracy of modeling results and decision making, but not a given that monitoring may drive decision making.
- Still unsure of the planning targets. It seems a foregone conclusion that there will be a p7 watershed model. With a new watershed model, planning targets will change, correct?
- It may be unreasonable to think the models can drive implementation in the future.
- We need to provide better context on utility of the model to policy makers using the model to make decisions...
- CAST and Bay modeling cover a lot- but ultimately the goals of the tools are to help make better decisions for bay outcomes and hold partners accountable for past efforts.
- Doing the same things we have tried 8 times over and expecting a different outcome
- "What we were doing 30 years ago, is a lot different than what we are doing now... We should probably expect continued levels of change moving into the future."
- the presentations were helpful, but I think there are a number of ideas for a wide range of topics. I'm not sure we've really touched many of those newer idea.
- Progress on nutrient load reduction is disappointing -- at first glance. Would there be benefits to estimating through modeling, and, showing what the current situation would be if no or few BMP actions had been taken?
- It is still unclear as to where we should start with prioritization of the work that should be done for Phase 7
- [no , the presentations did not change any recommendations]
- Yes, nuances reshuffled priorities
- No. Primary concern remains identifying priorities for future modeling efforts and where our efforts and energies should be targeted.
- Maybe, gave me more info, need to think it through.
- Regardless of changes made to modeling to reflect physical process simulation improvements, concern that modeling is being used for purposes beyond the TMDL

- Models should be able to help us focus our efforts moving forward in areas where there are the greatest needs in achieving targets, especially focusing the agricultural sector. Gear towards improving understanding of implementation actions.
- Models being able to demonstrate incremental progress in terms of WQ attainment can help support decision making.
- Tools can provide:
    - Scenarios and options.
    - Information on, but not determination of on-the-ground implementation
    - Demonstrate progress toward targets,
    - Ability to see impacts on WQ while planning for implementation.
    - Improve transparency and enhance communication with stakeholders.
    - It will also help identify for state and local stakeholders and decisionmakers needed technical resources and direct financial resources to meet those needs.
    - Evaluate progress of the partnership's efforts, year over year, and identifying where we did not achieve the goals we set.
    - Upfront communication about what spatial scales is model output most accurate and therefore usable is needed.
    - provide feedback that helps elucidate progress or lack of progress
    - CBP P7 models will provide the framework for a discussion on how to implement management practices for a better, healthier watershed and tidal Bay.
    - Identify specific 'value' of management efforts and predict what level of incentive is necessary to increase implementation.
    - Evaluate the incentive structures (what are we underpaying for, what are we overpaying for) of various programs that are directed towards achieving bay goals.
    - Provide information regarding which aggregate set of BMPs are associated improvements in load reductions where.
    - What was mentioned earlier (I think by James) related to ag land values/production costs/commodity prices is interesting. Don't know that could realistically be accommodated. cost of taking land out of production is critical to decision-making.
    - identify where state leadership can make the most influential policy decisions.
    - credit for air emission reduction.
    - Ability to track progress at a BMP level through portion of load changes in a year that came from specific practice types.
    - Identify where investments are needed, and where historic investments have been ineffective.
    - Evaluate land use change on a per capita basis.