# Findings from Running of Initial Ranging Scenarios through the Watershed and Bay WQ Models

Briefing paper for the WQGIT, Oct 24th, 11am

## Background

The airshed, watershed, and estuarine modeling tools that the CBP partnership uses to inform decisions are being significantly modified to incorporate new science and multiple lines of evidence for the Midpoint Assessment. The tools are expected to be complete and approved by June, 2017. Throughout 2016 and early 2017 development versions of the modeling tools are being reviewed by the partnership.

Starting with the Beta 3 version, completed in August 2016, the CBP is running preliminary, draft scenarios through the modeling tools. The purpose of these runs is to determine if the modeling system is performing similarly to previous versions. Given that the models are still in draft status, *only very general conclusions can be drawn from these early runs*.

The principal changes in the watershed model are new methods for inputs, phosphorus behavior, reservoir simulation, BMP characterizations, and overall model structure supported by multiple models. The estuarine model has some changes in the simulation of biogeochemistry and has added a simulation of wetlands.

## Scenarios chosen

**No Action** – starting with a 2010 land use, all BMPs are removed. Waste water is set to secondary treatment (18 mg/l N; 3 mg/l P). This is a watershed model run only and is not run through the estuarine model.

**1985** – Land use, management actions, and point sources are held constant at 1985 levels. Attainment results can be compared to the 1993-1995 observed to estimate the management-driven water quality changes between 1985 and the mid-1990s.

**2009** – Land use, management actions, and point sources are held constant at 2009 levels. Attainment results can be compared to the 1993-1995 observed to estimate the management-driven water quality changes between the mid-1990s and 2009

**E3** – Everything, Everywhere, Everyone scenario. All management practices are set to high levels of implementation. The specific rules for this scenario are currently being finalized by the CBP so some of the definitions for this scenario were determined by CBPO staff as a temporary measure. The current results are **highly uncertain** but they can be used to estimate the feasibility of attaining water quality standards under extreme implementation.
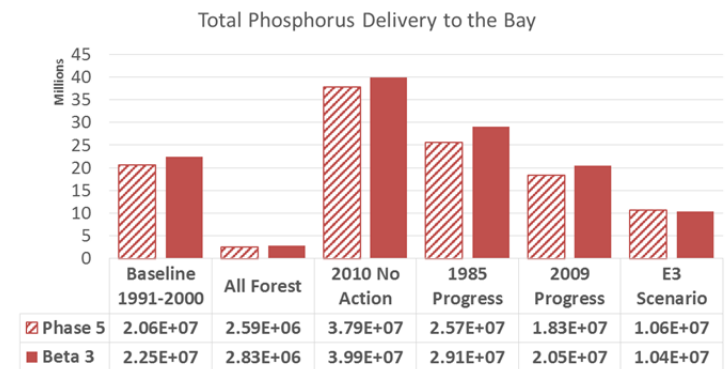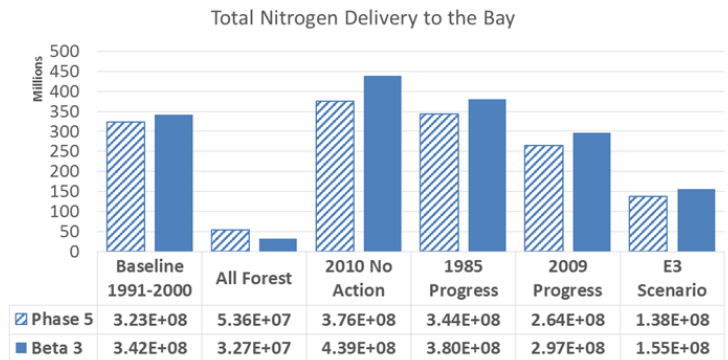
**All forest** – all land uses are replaced with forest, a low loading land use. Point sources are set to zero. This is a test of the estuarine model to see how it responds to loads that are unrealistically low to see if there are predictions of persistent dissolved oxygen problems.

## Watershed model results

It is important to remember that these models are still draft and still have significant development before they are finalized. The results should not be over-interpreted.

The results for the Phase 6 Beta 3 watershed model are consistently higher than the Phase 5.3.2 values at the CB watershed scale. This is an expected result given the higher loads from the coastal plain in the Beta 3 version.

The relative difference between scenarios is similar between phase 5 and phase 6 with the notable exception being nitrogen in the all-forest scenario. This result is expected given the lower loading rate assigned to forest in the multiple-model approach of Phase 6.

### Total Nitrogen Delivery to the Bay

| | Baseline 1991-2000 | All Forest | 2010 No Action | 1985 Progress | 2009 Progress | E3 Scenario |
|---|---|---|---|---|---|---|
| Phase 5 | 3.23E+08 | 5.36E+07 | 3.76E+08 | 3.44E+08 | 2.64E+08 | 1.38E+08 |
| Beta 3 | 3.42E+08 | 3.27E+07 | 4.39E+08 | 3.80E+08 | 2.97E+08 | 1.55E+08 |

### Total Phosphorus Delivery to the Bay

| | Baseline 1991-2000 | All Forest | 2010 No Action | 1985 Progress | 2009 Progress | E3 Scenario |
|---|---|---|---|---|---|---|
| Phase 5 | 2.06E+07 | 2.59E+06 | 3.79E+07 | 2.57E+07 | 1.83E+07 | 1.06E+07 |
| Beta 3 | 2.25E+07 | 2.83E+06 | 3.99E+07 | 2.91E+07 | 2.05E+07 | 1.04E+07 |

## Bay WQ model and attainability results

The chart at right shows the non-attainment of water quality standards for deep water under the draft Phase 6 Beta 3 scenarios. Green zeros indicate that the standards are met. Red percentages are the percent of non-attainment.

The chart on the following page summarizes the results and compares them against loading rates. The response of the model is compared to the previous version of the models. The change in loading relative to the calibration run is represented on the horizontal axis. The percent change in N and P loading is averaged. The vertical axis represents the change in volume-weighted non-attainment that results from the change in loading.

| Nutrient Start Cbseg | loading End State | Calibration 1993_1995 DO_M_DW | 1985_progress 1993_1995 DO_M_DW | 2009_progress 1993_1995 DO_M_DW | E3 1993_1995 DO_M_DW |
|---|---|---|---|---|---|
| CB3MH | MD | 2.06% | 3.26% | 1.14% | 0.01% |
| CB4MH | MD | 20.96% | 26.11% | 15.89% | 2.82% |
| CB5MH | MD/VA | 4.19% | 5.43% | 3.09% | 0.00% |
| CB6PH | VA | 0.00% | 0.41% | 0.00% | 0.00% |
| CB7PH | VA | 0.00% | 0.00% | 0.00% | 0.00% |
| CHSMH | MD | 25.70% | 34.02% | 19.88% | 0.00% |
| EASMH | MD | 5.89% | 29.16% | 2.72% | 0.28% |
| PAXMH | MD | 6.30% | 12.96% | 3.96% | 0.00% |
| POTMH | MD/VA | 4.12% | 5.93% | 3.03% | 0.00% |
| RPPMH | VA | 5.86% | 9.49% | 3.92% | 0.00% |
| SBEMH | VA | 0.03% | 7.77% | 0.00% | 0.00% |
| YRKPH | VA | 0.00% | 0.00% | 0.00% | 0.00% |
| PATMH | MD | 12.44% | 21.97% | 3.57% | 0.00% |
| MAGMH | MD | 51.01% | 57.13% | 43.25% | 1.94% |
| SOUMH | MD | 18.59% | 32.09% | 13.54% | 2.96% |
| SEVMH | MD | 6.08% | 13.41% | 6.08% | 0.00% |

**Estuarine Model Response to Loads**
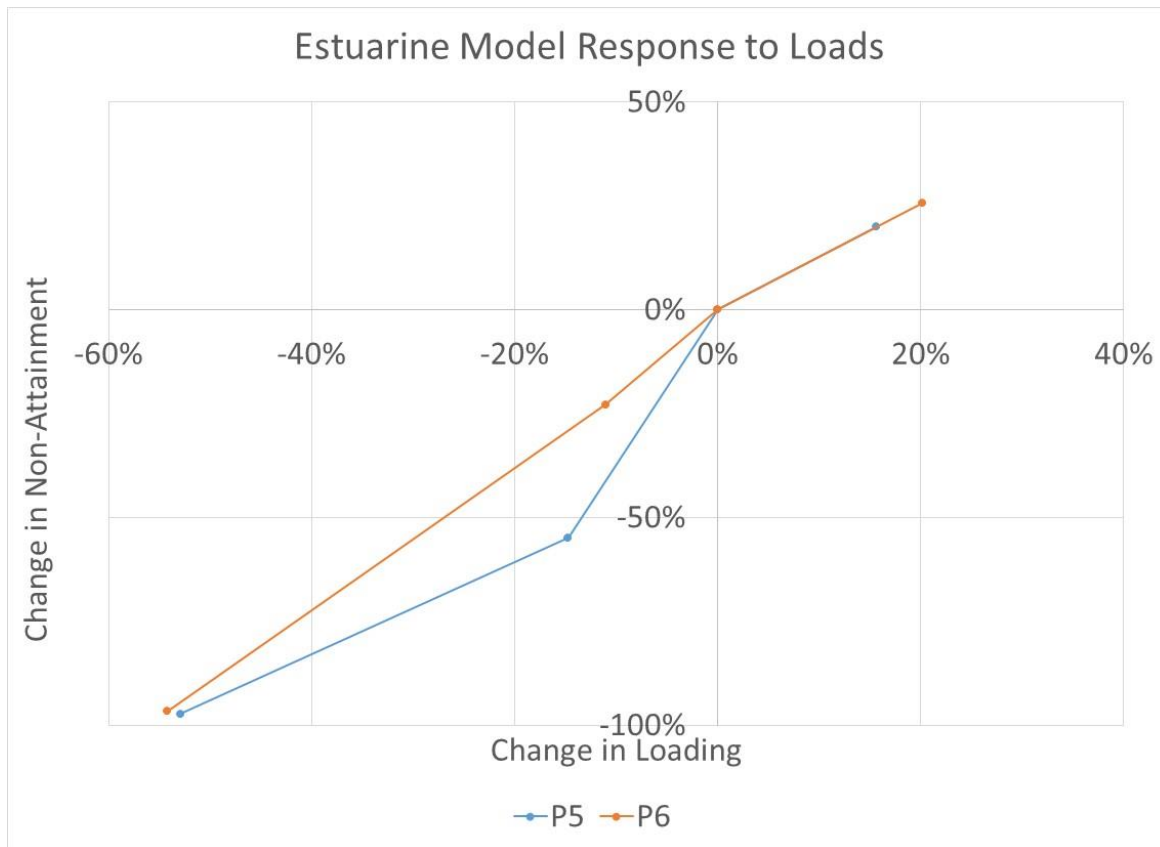
The chart above shows the estuarine Water Quality and Sediment Transport Model is generating similar results as the previous version of the model across increases and decreases in nutrient loads. There are some differences in the response. However, these results are very preliminary generated by draft versions of the models and should not be over-interpreted. In general, the modeling system can be said to be consistent with previous versions.

## Decision Requested
Agreement on follow through actions in response to preliminary scenarios.

## Recommended Actions
CBPO Scientists continue to work with the partnership to develop the watershed and estuarine models on schedule.

Periodically bring back results to the WQGIT.

## Visualization of Results

In an effort to provide access to the scenario results in a timely manner, CBP is concurrently developing approaches for visualizing scenario output.  Prototypes of interactive tools for both watershed model and estuarine model preliminary results will be demonstrated at the WQGIT meeting.  Initial tools will focus on two objectives: (1) enabling the user to make side-by-side geographic comparisons of the output of alternative scenarios, and (2) enabling the user to investigate scenario output in conjunction with other map data layers important to the Midpoint Assessment.

In addition to these geographic data viewers, ideas for alternative approaches for interactive visualization of scenario outputs will be solicited.