Baltimore Harbor TMDL Stakeholder Advisory Group (SAG)
April 9, 2003 Meeting Minutes

Maryland Department of the Environment
Montgomery Park
Baltimore, Maryland
9:00 - 3:30

Overview:

The meeting consisted of presentations by the University of Maryland and Virginia Institute of Marine Sciences on the toxic metals modeling effort each is undertaking. Included were presentations on the sediment transport, hydrodynamic, and water quality models developed by both institutions.

Presentations

Introduction to University of Maryland Modeling Approach (Joel Baker)

Goal: Overview of modeling objectives and strategy

Highlight Utility of Models to Develop TMDLs

- Models are used to relate loadings into a specific environment to concentrations in that environment.
- Management decisions must take into account the relationship between contaminant loads and the resulting concentrations.
- UMCES model algorithms are similar to other established models.

Provide General Introduction to Sediment Transport Model

- Chao and Sanford adapted the Princeton Ocean Model (POM) to the bathymetry of Baltimore Harbor and greatly enhanced the sediment transport components of the POM.

Provide General Introduction to Chemical Contaminant Model

- The chemical contaminant model is driven by a fine-scale hydrodynamic/sediment transport model (enhanced POM).
- Water and sediment movements are modeled with a relatively fine spatial resolution and the resulting output 'collapsed' on a coarser '24-box' grid for the chemical contaminant model.
- Based on field partitioning studies and literature studies, a kinetic model of contaminant exchange with solids is used.

Q&A

1) The model is described as a generic model? How is it generic? Can it handle specific types of chemicals?

   Response: the model is built to handle any chemical as long as you know the partitioning coefficient, the mass transfer coefficient, and the 1st order chemical reactivity of the material. The model does not specifically model individual species of chemicals - the approach has been to use field derived data to develop an understanding of what is occurring in the harbor

2) Did you look at the total, dissolved, and particulate phases for metals?

   Response: yes

Detailed Presentation on the UMCES Sediment Transport Model (Larry Sanford)

Goal: Provide detailed explanation of the sediment transport model.

Overview of Physical Parameters Influencing Sediment Movement

- Very weak tidal circulation, especially in middle and inner harbor
- Three layer circulation important on long time scales, not in daily circulation patterns.
- High sediment import occurs near the bottom in the channel and it doesn't migrate into the harbor a long distance.
- Large wind and wave events are important, especially in outer harbor.

Overview of Transport Model Components

- Circulation model is implementation of Princeton Ocean Model (POM). 61 day total simulation period - 30 day spin-up, use results from last 31 days.

Overview of Measures of Performance

- Sediment mass balance
- Comparison to time series data
- Comparison to monthly averaged data
- Comparison of measured and modeled sedimentation rates

General Conclusions of Sediment Transport Model

- Fast settling particles dominate erosion and deposition rates
- Slow settling particles dominate water column concentration and horizontal transport
- Medium settling particles contribute to both, but to a lesser extent

Q&A

1) Why was 2cm chosen as the sediment thickness of the surface layer?

   Response: 2cm was chosen because it was the sediment depth chosen by the field program. Therefore, the depth was chosen for consistency.

2) Do your results indicate that the contaminants found in the upper 2cm are the results of current loads and not the result of legacy pollutants?

   Response: Given the model assumptions that would be the case. The model does not consider bioturbation as a mixing mechanism.

3) Would the regulatory agency use dissolve chemical concentrations to evaluate against ambient water quality guidelines?

   Response: Yes, MDE will evaluate dissolved chemical concentrations against the ambient water quality criteria. However, keep in mind that the water quality impairments in the Baltimore Harbor are sediment based and not water column impairments.

4) What is the associated rate of error with this model?

   Response: The model is not designed to give perfect agreement between predicted and ambient conditions. It is not driven by perfect boundary conditions. The goal of the model is to simulate the characteristic behavior of the transport of suspended solids under different forcing conditions. In the more average sense, the model replicates the processes occurring in the harbor.
   MDE's two-pronged approach employs two different methodologies. The UMD approach uses a sophisticated modeling approach that is aggregated to produce overall conditions that are similar to observed data. Whereas the VIMS approach utilizes a finer scale and is focuses on replicating actual measured conditions. The UMD approach is based on using the box

model as a screening tool that replicates the physical and chemical features of the ecosystem – but not for specific time periods.

5) Do you feel that the 'calibration' periods you have are representative of environmental conditions you are trying to simulate? Particularly in regards to rainfall and the associated watershed inputs.

   Response: The runoff from the watershed does influence local conditions, however the flow is not significant in influencing sediment transport within the harbor. The volume of water that moves through the estuary via tidal, wind, and bay energy inputs influence the Baltimore Harbor more than watershed flows.

Detailed Presentation on the UMCES Chemical Contaminant Model (Joel Baker)

Goal: Provide detailed assessment of chemical contaminant model

Overview of Carbon Model

- To a first approximation, chemical contaminants associate with the organic carbon fraction of suspended and bed sediments.
- This model is carbon based, using POC transport parameters derived from the physical transport model.
- Output is in units of mass contaminant/mass organic.

Model Summary

- Model is numerically stable and consistent 10 year simulation + spin up in <12 hours
- Model conserves water, salt, particles and chemical contaminants
- Modeled carbon pools similar to observed values without tuning
- Spatial distributions in sediment concentrations are similar to observed

Q&A

1) Is it a concern that the model cannot model the various species of chromium – given the differences in behavior and toxicity in its various forms?

   Response: No, to build a model that could model the various species of chromium would require a variety of data and other inputs that are not compatible with a model that represents the harbor as a whole. In general, the partitioning coefficient serves to relate many of the processes that account for the various forms of chromium – and the associated toxicity – to its presence in the environment.

2) How does MDE plan on linking the sediment endpoint (ERM-Q) to the sediment concentrations predicted by the model?

   Response: The sediment endpoint (ERM-Q = 0.5) is a concentration that is predictive of a certain probability of toxicity (~20%) in the sediment. The concentration equal to the ERM-Q (i.e. zinc = 205 ppm) will be used in the modeling effort. The requirements of the TMDL are met when either the toxicity bioassay indicates that sediment concentrations are at or below a certain level of toxicity, or that the spatial mean concentration for a segment is at or below the ERM-Q (i.e. zinc = 205 ppm), and there are no sites at > 2X ERM (i.e. zinc = 820 ppm [ERM = 410 ppm]). Any toxicity issues present at this time will be reevaluated by the Department.

Detailed Presentation on the VIMS Hydrodynamic Model (Harry Wang)

Goal: Provide detailed assessment of hydrodynamic model

Overview of Hydrodynamic Model Components

- Three-dimensional free surface, hydrodynamic model
- Non-orthogonal boundary fitter coordinates
- Finite difference scheme
- Computing information - total of 16149 active grid cells, horizontal resolution: 0.2 km lateral and 0.4 km longitudinal –time step = 3 minutes: perform in Dec-alpha; 18 hour CPU for 365 days

Model Summary

- The long-term temporal variation of tidal elevation, salinity, and temperature were well calibrated from 1992-1997. Seasonal averaged spatial patterns were also verified.
- The modeled bottom current, salinity, temperature and TSS compare well with short-term, intensive measured data in spring of 2000.

Detailed Presentation on the VIMS Sediment Transport Model (Harry Wang)

Goal: Provide detailed assessment of sediment transport model

Overview of Sediment Transport Model Components

- Model simulates long-term transport for years 1995, 1996, and 2000
- Model simulates short-term transport for CHARM2 time period
- Three sediment classes (3.5, 15, 65 μm)
- Concentration dependent settling velocity
- Depth dependent erosion formulae in Baltimore Harbor

Model Summary

- The TSS long-term simulation covers different hydrological years: 1995 (very dry), 1996 (wet), 2000 (dry). The modeled TSS results appear reasonable when compared with Upper Bay and Baltimore Harbor monitoring data.
- High TSS variability occurs during the spring. The model simulates currents, salinity and TSS very well during CHARM2, including a period with a high wind event.
- The model indicates that a combination of discharge from the Susquehanna River, and high wind and waves contribute to the episodic, high TSS concentrations in the Harbor.
- Model outputs show high TSS concentrations are the result of local resuspension and transport from outside the Harbor.
- Local resuspension is mainly composed of fine sand, while transport from outside is mainly silt and clay.

Detailed Presentation on the VIMS Toxics Water Quality Model (Jing Lin)

Goal: Provide detailed assessment of toxics water quality model

- The toxics model receives inputs from the CH3D hydrodynamic model, SWMM watershed model, and point source loads. These inputs are entered into the WASP kinetics module in conjunction with the ICM transport model to create the toxics model.
- Toxics model includes sediment mixing and burial parameters to represent sediment dynamics
- Toxics model grid is subsection of upper Chesapeake Bay grid design

Q&A

1) The sediment concentrations are reported in mg/L, what does the liter stand for? Is it a liter of sediment? Reporting convention for sediments is on a mass/mass basis.

   Response: This needs to be reevaluated to ensure the appropriate units are used

2) Would it be possible to test a hypothesis using the model output to compare against a known data set? What would be desirable is a quantification of the difference between model results and limited data that is available.

   Response: Since models are based on hypotheses you cannot use them to test a hypothesis. To conduct a statistical analysis of the type requested requires the quantification of uncertainty for both sets of information – this is not available.
   Furthermore, the standardized statistical analysis requested is applicable to static data sets. However, with highly dynamic data sets (i.e., a phase lag in a reaction in a time series measurement) the difference in time between model simulation and the actual event results in a statistical analysis error because the analysis cannot differentiate between the subtle shift in time between simulated and actual events. The statistics will indicate the model does not simulate the observed data, however it may be a matter of hours or minutes in which the model replicates the observed phenomena. In modeling a dynamic system, the goal should be to ensure that the model replicates the major features that occur within the system and not to focus on a point by point comparison of data.

3) If the models and data are similar, will MDE consider that sufficient for ensuring the models are appropriate to develop the TMDLs?

   Response: MDE realizes the difficulty in the situation. However, the relative scale at which contaminants are present is important to remember when conducting an assessment of reasonableness in the model results. In the water column the model results are reasonable - the water quality standards are much higher than the contaminant levels that have been measured and are being modeled. Therefore, small amounts of error associated with model results do not cause concerns of the overall outcome because the levels of contaminants are well below the water quality criteria.

   Given that sediments are what the TMDLs are being developed for, understanding the factors that affect sediment concentration are of higher concern for MDE. By ensuring that the models replicate the physical and chemical processes occurring in the sediments, MDE will ensure that the results of the models provide the most useful and accurate information needed with best available data to make management decisions.

4) Are UMCES or VIMS going to provide MDE with metals concentrations in porewater? If so, do you feel it will help develop a clearer picture of the relationship between sediment concentrations, toxicity, and dissolved concentrations?

Response: The models produce porewater concentrations, however a lack of field data precludes any thorough direct comparison of measured and predicted concentrations.

5) Is this seen as a drawback to the model?

Response: The lack of data to verify porewater concentration is somewhat of a concern. To the extent that the models simulate what is occurring in the system and predict reasonably the levels of contaminants in the water column, it is assumed that the models are of sufficient quality and accuracy to complete the TMDLs.
The ability of the models to represent the sediment transport and water column accurately indicates that it is also representing the sediment relationships well. To the extent that there is some error

associated with this relationship is acknowledged. However, the sediment relationships (e.g., partitioning and mixing) play vital roles in determining the fate of a chemical. Therefore, by ensuring the models account of the physical and chemical processes that occur in the water column and the sediment MDE feels the models will provide reasonable results.

6) Will MDE be running multiyear scenarios?

Response: Yes, MDE will be running multiyear scenarios. MDE will choose critical years (i.e., wet and/or dry hydrologic years) to run the models, such that a set of bounds is created for expected outcomes in the harbor. MDE will run the baseline scenarios provided in the handout to determine which direction the TMDL development scenario runs should proceed in. This handout will be available in MDE SAG website along with today's presentations for review.

MDE also understands there will be a lag time associated with the change in loads and corresponding change in sediment concentrations. The goal will be to use the models to help us evaluate the length of this lag time and the extent of the sediment concentration reductions given a specific load reduction.

7) Will MDE consider using actual hydrologic data as opposed to simulated critical year data as a way to represent actual conditions in the watershed and harbor?

Response: Yes, MDE will consider this option. However, model run times and computer storage space and the expected utility will need to be factored into the decision. This will be discussed further.

8) The distribution coefficient for metals – are both modeling approaches using the same coefficient? If so, have you done a sensitivity analysis on that number?

Response: Yes, both modeling approaches are using the same coefficient and yes a sensitivity analysis has been conducted. The coefficient is a measured value and does have variability associated with it.

Additionally, the real issue at hand is whether the current loads into the harbor result in the current sediment concentrations or whether the sediment concentrations are influenced by legacy pollutants. MDE will run a scenario to address this question first.

Comment: In the Anacostia River program, the water column concentration of contaminants seem to be sensitive to the partitioning coefficient K_d value used in the model, however the sediment concentration does not appear to be sensitive to K_d.

9) Do the models have processes that simulate the mixing of sediments? Does MDE have data that would support the development of a mixing term in the equations to simulate mixing of legacy contaminants?

Response: Based on sediment core data from Jeff Cornwall at UMD there appears to be burial occurring in the harbor. Also, the harbor, in general, is a net depositional environment. Based on this information, the legacy pollutants associated with these older sediments must be buried. Therefore, either current loads or a combination of current load and the mixing of older sediments back to the surface account for the sediment concentrations observed in the surface sediments of the harbor. Therefore, there needs to be a mixing term in the models to account for this process.

A way to test this assumption is to run the models with current loadings and clean sediments with no sediment mixing and allow the model to reach steady state. Once this occurs, determine if the

sediment concentrations are appropriate. If the concentrations are lower than measured values then either a mixing term will need to be added or the loads reassessed.

10) Will UMCES and VIMS submit to MDE a model report prior to completion of the draft TMDL? Will this report contain a detailed description of the models? Will these reports be distributed to stakeholders for review?

Response: Yes, reports will be developed by UMCES and VIMS and submitted to MDE. The reports will also be reviewed by MDE and subsequently released to stakeholders for review prior to the finalization of the TMDLs.

11) What is the baseline scenario that will be run?

Response: The baseline scenario is listed on the scenario handout. The idea is to incorporate current point and nonpoint source loads with current sediment concentrations and determine if sediment concentrations decrease over time. The other scenarios included in the hand out represent other versions of model runs that will help develop the scope of the remaining model runs.

Next Steps

UMCES and VIMS will attempt to run the baseline scenario and have draft results for the SAG prior to the May 1, 2003 meeting. MDE will work with UMCES and VIMS to facilitate this process.

. Scheduled Meetings: All Meetings Scheduled to be held at the MDE offices at Montgomery Park

May 1, 2003 – General Outreach Meeting
June 10, 2003 – General Outreach Meeting
July 30, 2003 – General Outreach Meeting
Other technical meetings will be scheduled as needed