Trapping Capacity of Dams and Local Impoundments

The Chesapeake Bay TMDL's Midpoint Assessment WQGIT Meeting

October 8, 2014

Lewis Linker and the CBP Modeling Team

Chesapeake Bay Program
Science, Restoration, Partnership

Overview and Background:

- Wrap up of CoE Lower Susquehanna River Watershed Assessment (LSRWA) Report and Ancillary Work
  - Public release of report targeted for a late October/November timeframe.
  - LSRWA findings
  - Publication of a special collection of papers on Conowingo infill in the Journal of Environmental Quality (JEQ) underway.
- New Studies Underway on Conowingo Infill
  - Studies of the particulate nutrients mobilized in the Conowingo Reservoir and transported to tidal waters directly support the 2017 Midpoint Assessment decisions on the Conowingo.
  - Follow-up with CBP model assessments of the new research and monitoring findings to improve estimates of Conowingo infill nutrient offsets.
- Simulating the Trapping Capacity of Other Reservoirs and Local Impoundments

LSRWA Wrap-Up

- STAC peer-review technical comments on the draft LSRWA report were delivered on August 22, 2014.

- STAC concurred with the report's major findings that:

  "1) The Conowingo Reservoir is essentially at full capacity and is no longer a long-term sink helping to prevent sediment-associated nutrients ….from entering the Chesapeake Bay.

  2) Increases in [nutrient] loads entering the Bay as a result of the full reservoir are likely causing significant impacts to the health of the Chesapeake Bay ecosystem.

  3) Sources of nutrients upstream of the Conowingo reservoir have far more impact on the Chesapeake Bay ecosystem than do the increases in nutrients caused by scour plus reduced deposition in the reservoir.

  4) Managing sediment via large-scale dredging, bypassing, and/or operational changes are not cost-effective ways to offset Chesapeake Bay water quality impacts from the loss of long-term trapping of sediment-associated nutrients."

LSRWA Wrap-Up *(continued)*

• A public review is currently planned to run from about late October to sometime in November and a public meeting could be scheduled any time during the public review period. The public review will run for about 45 days.

• The purpose of the public meeting will be the introduction of the findings of the report to the general public and to local, state, and federal agencies. The public meeting will probably be in a webinar format similar to what was done during the 2010 TMDL public review period.

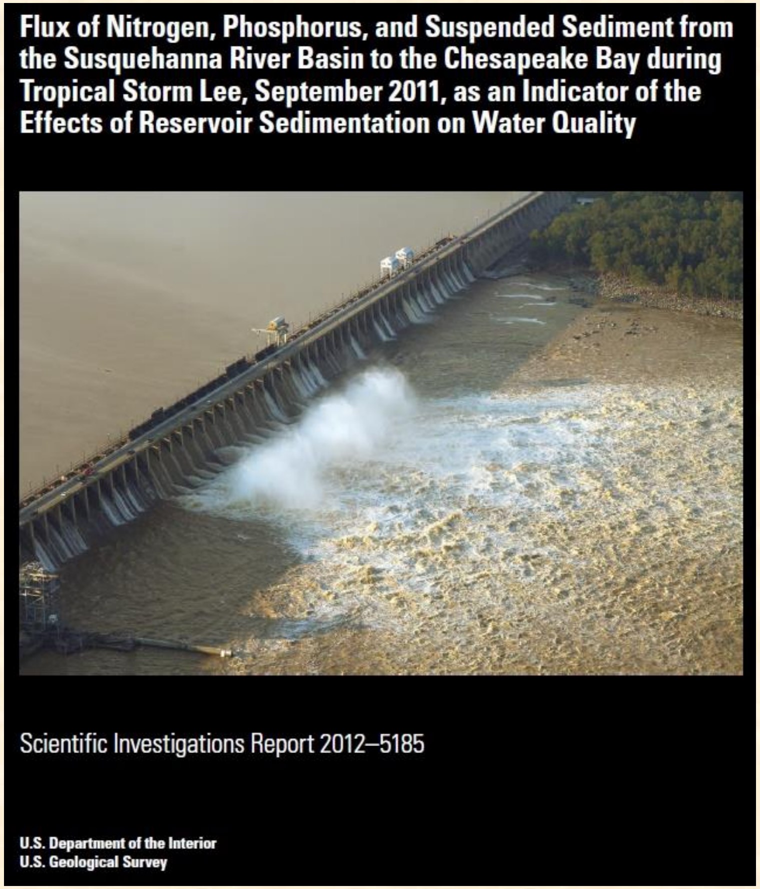
• The final LSRWA report will be released by about March 2015.

Background and Overview on Conowingo Infill

- The Conowingo Reservoir has been filling in with sediment for almost a century.

- It has acted like a BMP, but it’s a BMP that’s losing its effectiveness.

- When we developed the Chesapeake TMDL we thought the Conowingo was still effectively trapping sediment and nutrients but we find it’s now in a state of near-full capacity called dynamic equilibrium.

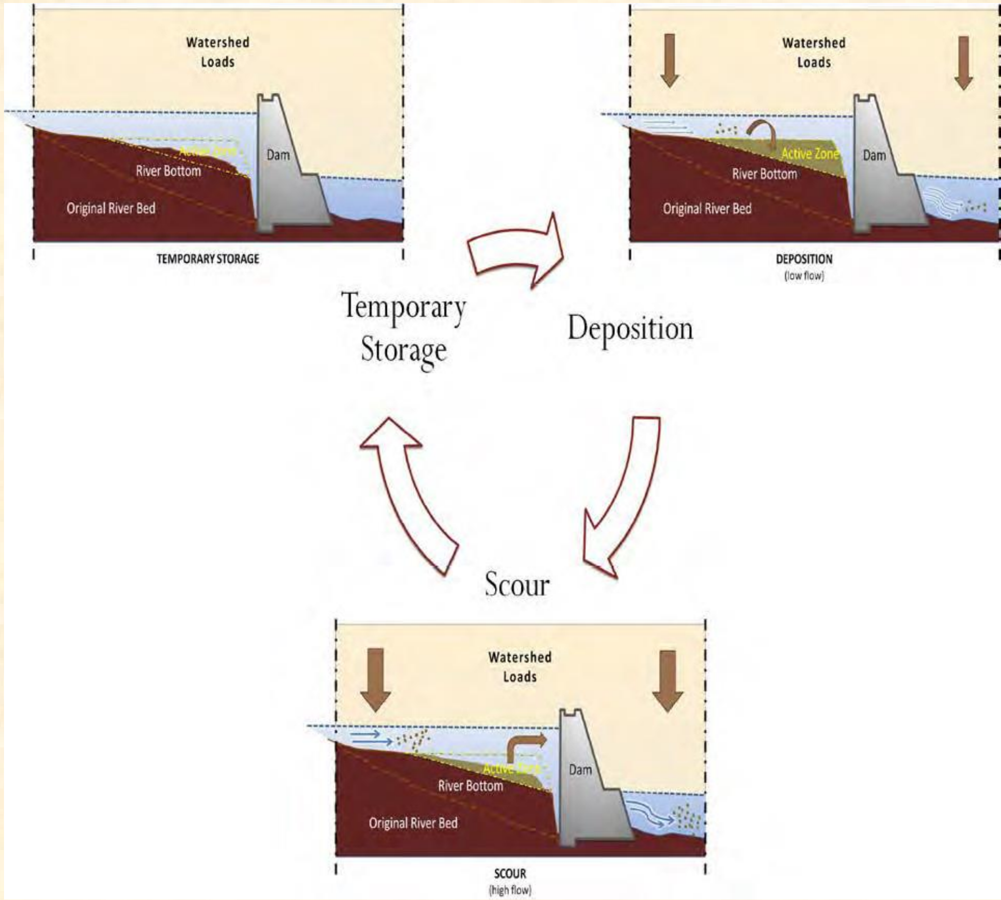

Flux of Nitrogen, Phosphorus, and Suspended Sediment from the Susquehanna River Basin to the Chesapeake Bay during Tropical Storm Lee, September 2011, as an Indicator of the Effects of Reservoir Sedimentation on Water Quality

Scientific Investigations Report 2012–5185

U.S. Department of the Interior
U.S. Geological Survey

Dynamic Equilibrium Means High Flow, Scour, Fill, Repeat.

Appendix T describes the case where "future monitoring shows that the trapping capacity of the reservoir has been reduced" and suggests that "then the Chesapeake Bay Program Partners will need to consider adjusting... milestone loads based on the new delivered loads to ensure that all are meeting their target load obligations."



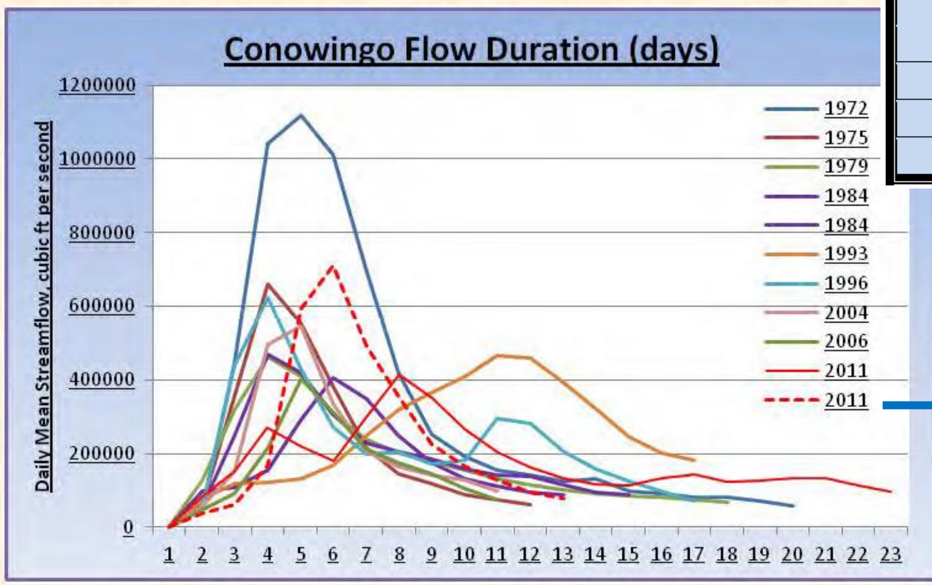
Conowingo Infill Causes Impairments To Chesapeake Water Quality

The estimated impairments are primarily on deep-water and deep-channel dissolved oxygen because of increased discharge and transport of particulate and organic nutrients from Conowingo sediments.

Conowingo Infill Causes Impairments To Chesapeake Water Quality

About 20 to 40 percent of the TS Lee sediment plume seen in the satellite picture is estimated to be because of lower Susquehanna reservoir scour, the rest was from the Susquehanna basin.

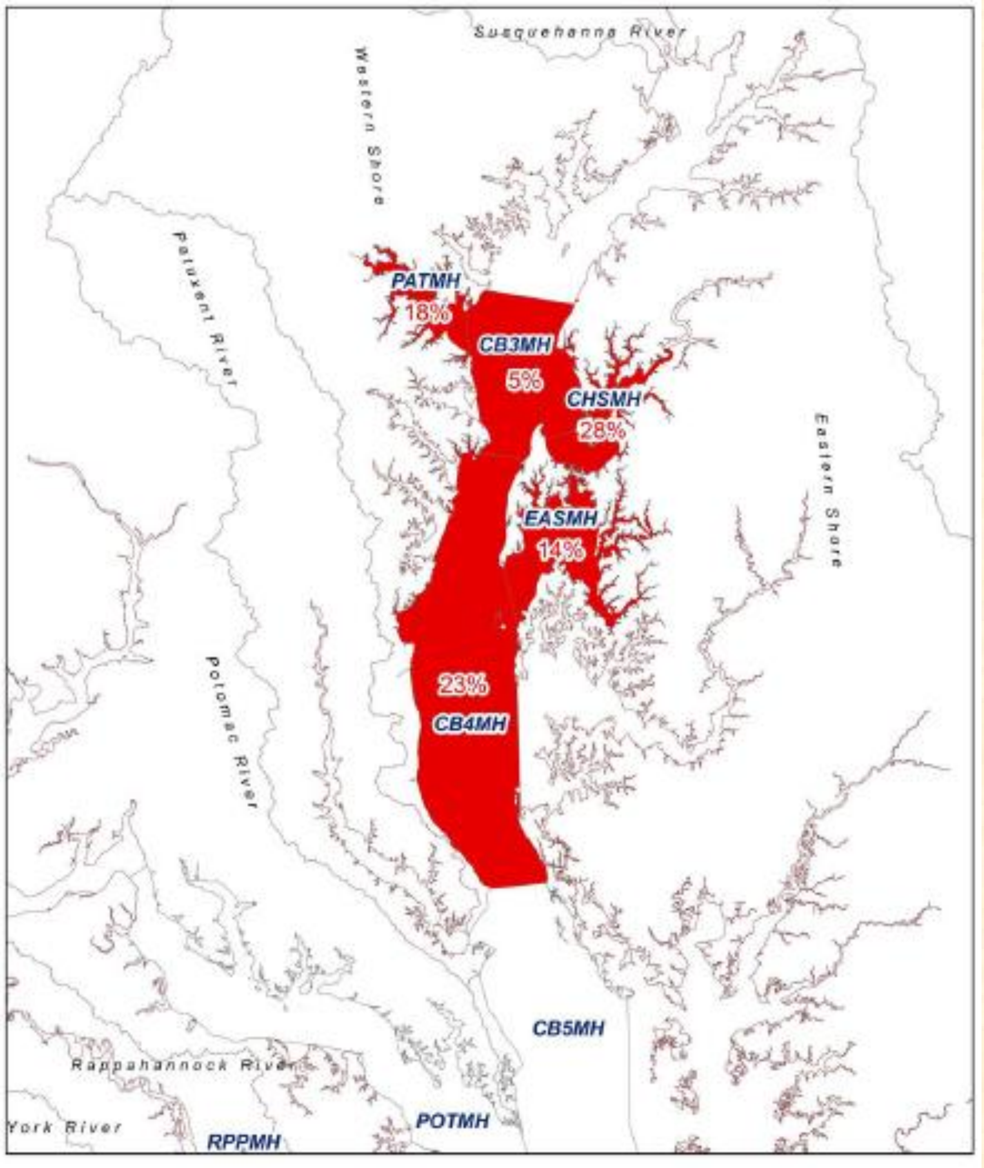
Streamflow (cfs)	Recurrence Interval (years)	Percent Chance of Flow Event per Year	Predicted Sediment Scour Range (million tons)[1]	Predicted Total Sediment Load Range (million tons)[2]	Percent Scour to Total Load Range
1,000,000	60	1.7	10.5 - 15.5	27.1 - 31.1	39 - 50
900,000	40	2.5	6.6 - 11	21.8 - 26.2	30 - 42
800,000	25	4	4.5 -7.5	17.2 - 20.2	26 - 37
700,000	17	5 .9	3.5 - 6	13.1 - 15.6	27 - 38
600,000	10	10	1.8 - 4	7.9 - 10.1	22 - 40
500,000	5.7	17.5	1 - 3	4.9 - 6.9	20 - 42
400,000	4.8	21	0.5- 1.5	2.4 - 3.4	21 - 44
300,000	1.9	52	0 – 0.5	0.5 – 1.5	0 - 33



Source: LSRWA draft report

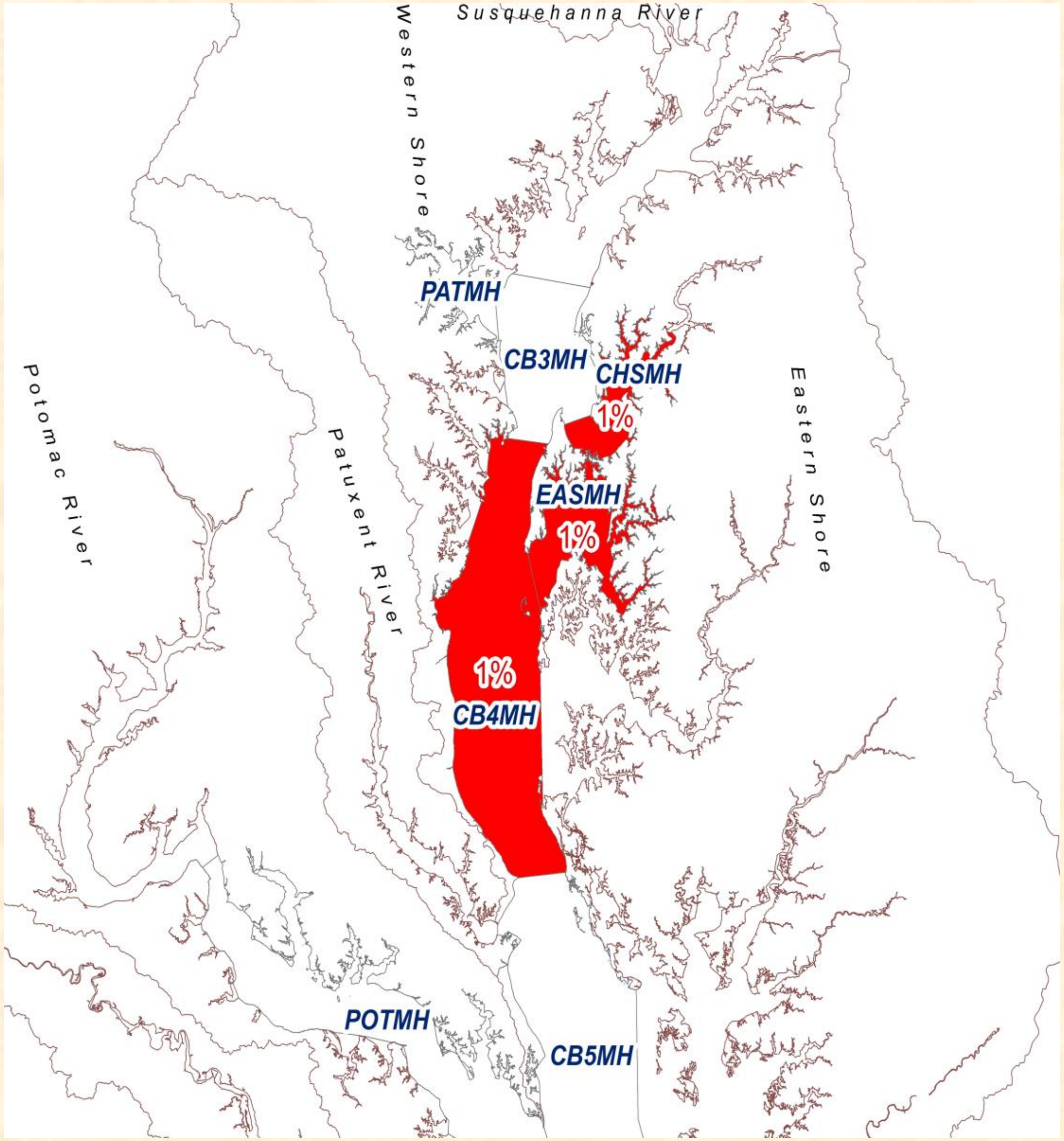
Estimated Deep-Channel DO Impairments Under 2010 Scenario Conditions…..

…but under conditions of full achievement of the Watershed Implementation Plans no impairments to the deep-channel DO water quality standard are estimated.



Deep-Channel DO Impairments Are Estimated Under Conowingo Scour Conditions

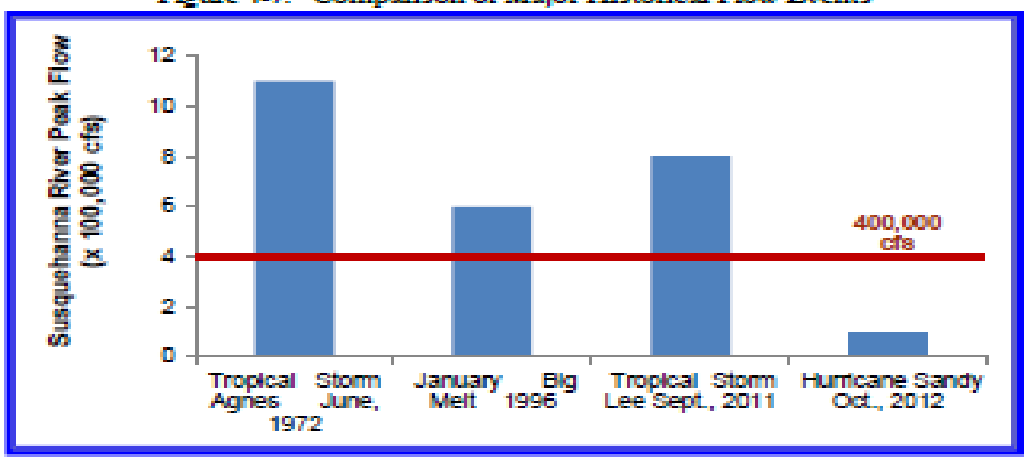
Estimated additional impairments with Conowingo scour under the January 1996 Big Melt conditions compared to no Conowingo scour under WIP conditions.



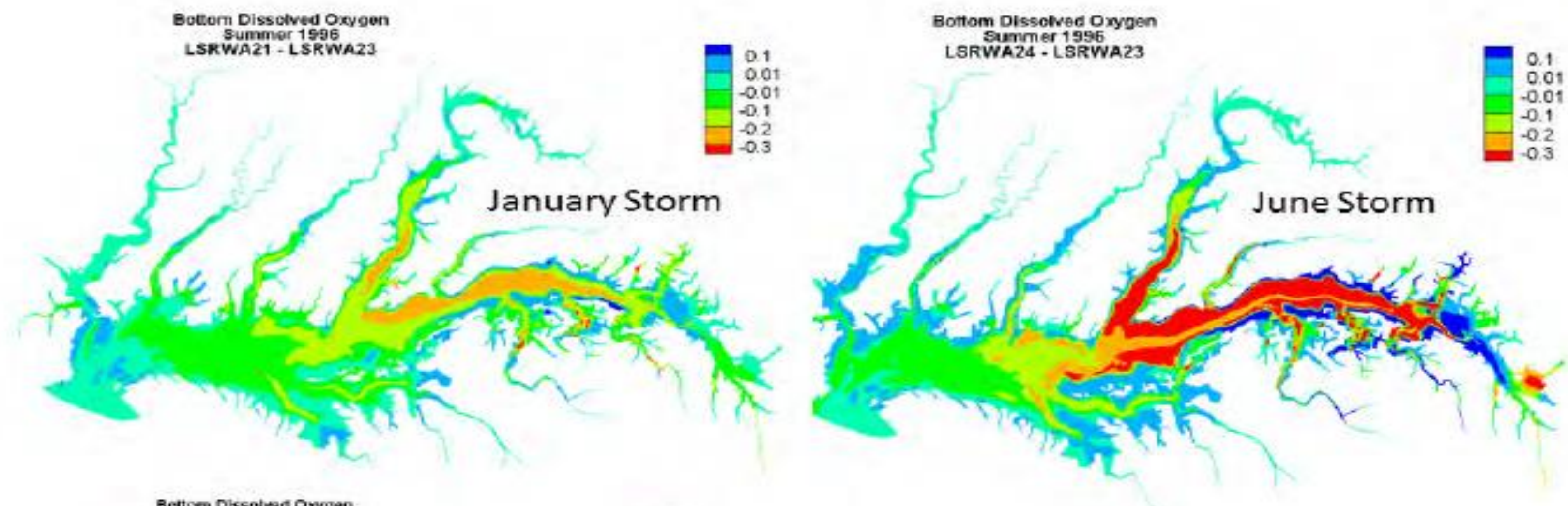
Key LSRWA Scenarios - Deep-Channel Segments

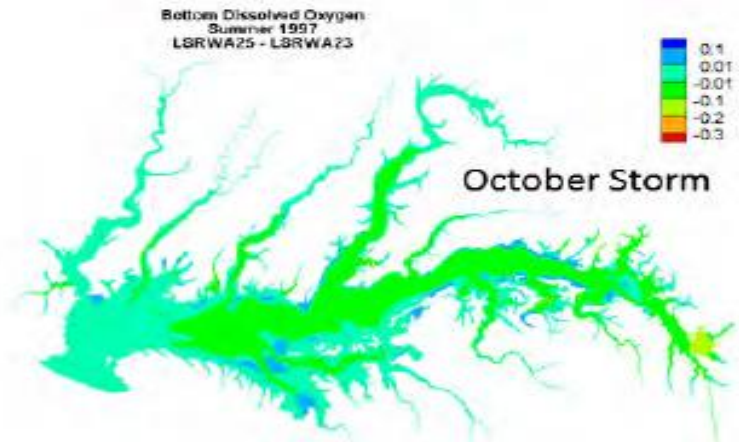
Scenario → Year → CB Segment	1985 Scenario 353 TN, 24.6 TP, 10100 TSS '93-'95 DO Deep Channel	2007 Scenario 269 TN, 19.5 TP, 8770 TSS '93-'95 DO Deep Channel	2010 Scenario 263 TN 19.4 TP 8360 TSS '93-'95 DO Deep Channel	TMDL Scenario 191 TN 15 TP 6675 TSS '93-'95 DO Deep Channel	E3 2010 N-Based Scenario 135 TN, 10.4 TP, 4850 TSS '93-'95 DO Deep Channel	All Forest Scenario 54 TN, 2.6 TP, 1340 TSS '93-'95 DO Deep Channel	Increase of nonattainment under January 1996 Big Melt flow conditions 96-'98 DO Deep Channel	Increase of nonattainment January compared to No Storm Scenario 96-'98 DO Deep Channel	Increase of nonattainment June compared to No Storm Scenario 96-'98 DO Deep Channel	Increase of nonattainment October compared to No Storm Scenario 96-'98 DO Deep Channel	Increase of nonattainment under moderate high flow conditions 96-'98 DO Deep Channel
CB3MH	17%	12%	5%	0%	0%	0%	0%	1%	1%	0%	0%
CB4MH	49%	40%	23%	1.00%	0%	0%	1%	1%	4%	0%	2%
CB5MH	17%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%
CHSMH	39%	36%	28%	15%	5%	0%	1%	2%	8%	1%	1%
EASMH	29%	24%	14%	1%	0%	0%	1%	2%	3%	0%	3%
PATMH	42%	25%	18%	0%	0%	0%	0%	0%	0%	0%	0%
POTMH	20%	13%	0%	0%	0%	0%	0%	0%	0%	0%	0%
RPPMH	23%	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Figure 4-7. Comparison of Major Historical Flow Events



Computed Change In Bottom DO Resulting From Storms In January, June, and October





Computed change in bottom DO concentration (mg/l) resulting from storms in January, June, and October, averaged over June - August. Positive values indicate an increase relative to the No Storm Scenario; negative values indicate a decrease. Note that the results for the October 1996 storm are shown for 1997 since the storm occurs at the end of the 1996 SAV growing season.

Source: LSRWA draft report Appendix C

New Studies Underway on Conowingo Infill

Upstream Inputs

- Inputs to Conowingo Pool – P Characterization
- N and P release during decomposition experiments

Reservoir Processes

<u>Biogeochemistry</u>

- Net exchange of N and P
- Pore water/solid phase characterization
- Spatial distribution of organic matter reactivity
- Grain size, porosity, non-reactive carbon (coal)

Conowingo Dam Particulate Efflux

- Particle settling behavior
- Form and potential reactivity of P
- Decomposition experiments to assess N and P bioavailability

Impact on Bay Processes

<u>Biogeochemistry</u>

- P release as a function of salinity/redox
- N decomposition rates
- SFM modeling of results

<u>Transport/Deposition of Particulates</u>

- Event-based sampling of particle distributions and physical forcing
- Radionuclide identification of “new” deposits
- Modeling of particle sedimentation

The studies directly support the 2017 Midpoint Assessment decisions on Conowingo infill. Projected start in Fall 2014, and studies will conclude in ~18 months (Early 2016).

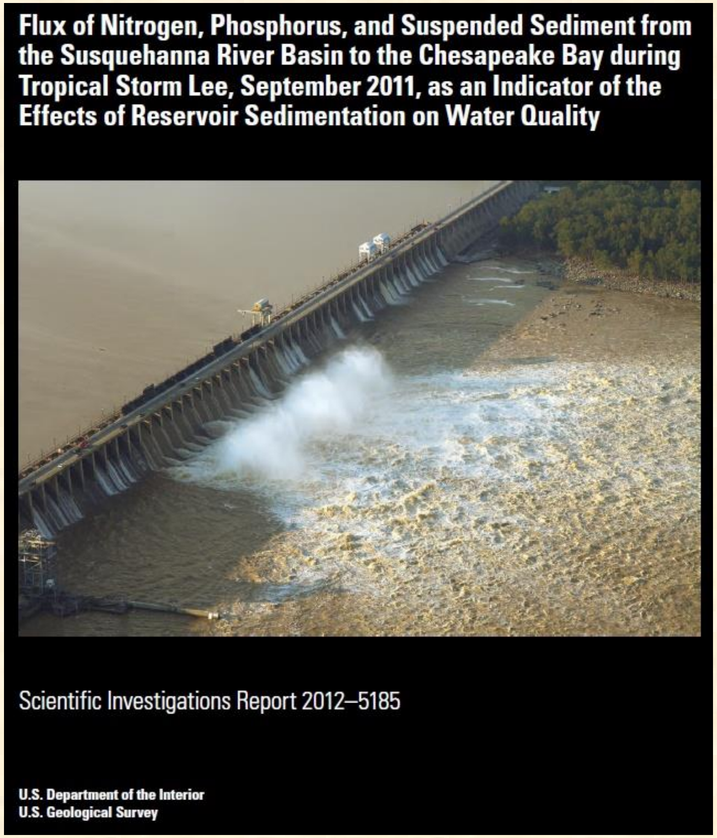
Source: J. Cornwell October Modeling Quarterly Review

New Studies Underway on Conowingo Infill

- Follow-up in 2016 with CBP model assessments of the new research and monitoring findings to support final decisions on Conowingo infill during the 2017 Midpoint Assessment.

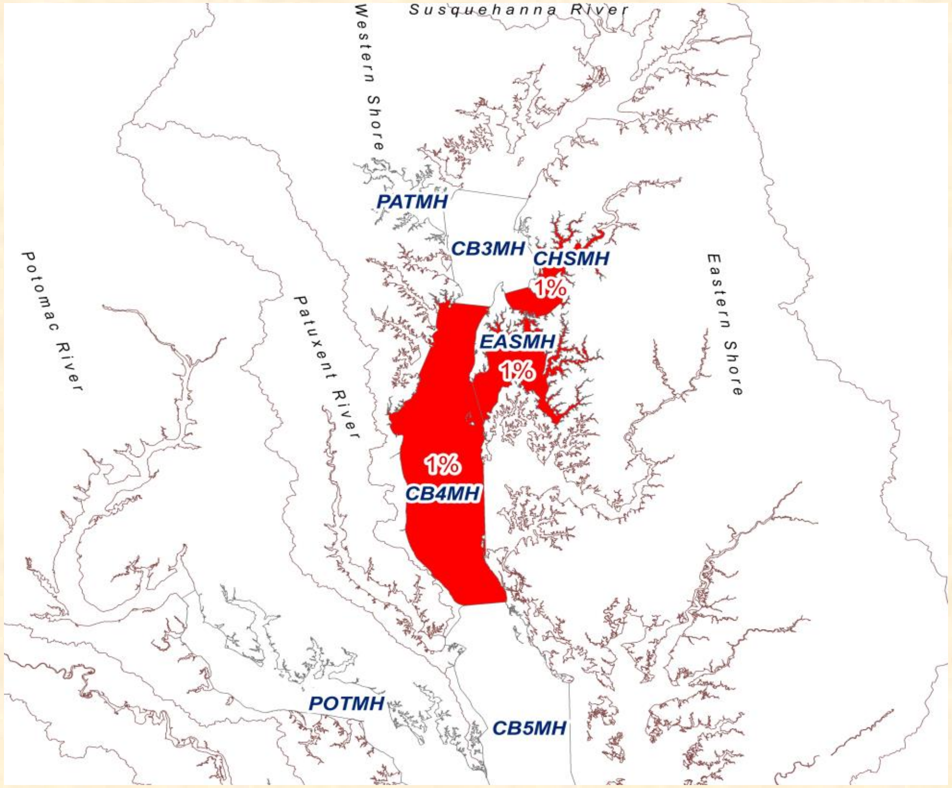
- The work will provide the best resolution of the effect Conowingo infill has on the Chesapeake TMDL.

- The studies will also better resolve questions of how the more frequent moderate high flows of between 100,000 cfs to 400,000 cfs influence Chesapeake water quality (Robert Hirsch, 2012). (The LSRWA study only addressed high flows greater than 400,000 cfs.)



Current Estimates of Reductions Needed to Offset Conowingo Infill Loads:

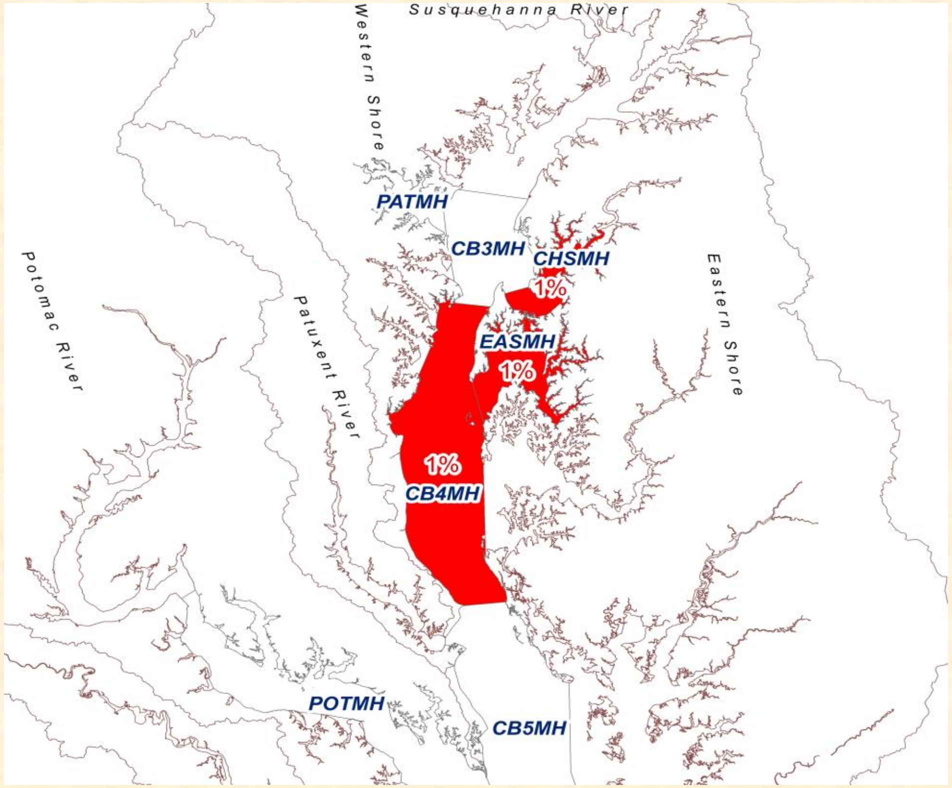
To provide a first order estimate of the degree of the Bay-wide nutrient pollutant load reduction needed to avoid estimated increases in DO nonattainment due to Conowingo Reservoir infill, the key CBP scenarios (No-Action, 1985, 2010, WIP, E3, All Forest) can be used to assess the degree of attainment under different scenario loads of nutrients. Using the slope of the lines relating TN and TP to percent non-attainment of CB4MH Deep-Channel, <u>a rough estimate of the load reduction needed Bay-wide to offset a 1 percent nonattainment is about 4.4 million pounds of total nitrogen and 0.41 million lbs of total phosphorus.</u>



Particulate nutrients mobilized by the Conowingo infill condition are estimated to result in about 1% nonattainment in the Deep Channel of CB4MH, EASMH, and CHSMH.

Current Estimates of Reductions Needed to Offset Conowingo Infill Loads:

Other scoping scenarios provide an estimate of the nitrogen and phosphorus pollutant load reductions from the Susquehanna River watershed needed to offset the increase in DO nonattainment. In this case, a nutrient reduction solely from the Susquehanna River watershed to offset the increase in DO nonattainment from Conowingo Reservoir infill would be about 2.4 million pounds of nitrogen, or alternately a reduction of 0.27 million pounds of phosphorus.



Particulate nutrients mobilized by the Conowingo infill condition is estimated to result in about 1% nonattainment in the Deep Channel of CB4MH, EASMH, and CHSMH.

A Special Collection of Four Papers on Conowingo Infill in the Journal of Environmental Quality (JEQ) Is Being Prepared

- An article introducing the special collection and describing the various articles in the collection and their relation to each other and to issues of environmental management.

– The second article introducing the topic and covering Conowingo history and background, estimated sediment budgets, bathymetry, cores.

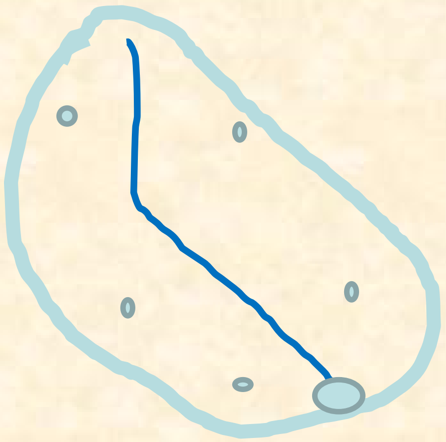
– The third article will focus on the simulation of the January 1996 Big Melt high flow event. Included will be the estimate of particulate nutrients from 1996 January event and their influence on Chesapeake DO, chlorophyll, and water clarity.

– Concluding the series will be a discussion of the Chesapeake TMDL, water quality standards, and the estimated water quality standard response to 1) the 1996 January event, 2) the response to simulated June and October events, and 3) an estimated response to moderate flow events.

Other Reservoirs and Impoundments

The 2011 Chesapeake SPARROW Model found that reservoir reductions were related to the relationship between surface area and flow, leading to an estimate of an apparent settling velocity for total nitrogen and total phosphorus. This information will be incorporated into the Phase 6 Model to represent other reservoirs in the Chesapeake watershed.

There are ~ 80,000 SPARROW segments with 4,325 reservoir/impoundments rather than ~ 40 reservoirs in 1,000 segments represented in Phase 5.3.2.



Small Impoundments

In Phase 6 small impoundments could be addressed by the USGS NHD data base, or the USGS Dynamic Water Data Base now under development. The Dynamic Water Data Base would provide an estimate of small impoundments from the mid-1980s to the present. It's an algorithm that estimates "surface water persistence on the landscape at a 30m resolution". We expect a draft Dynamic Water Data Base data set by December this year and expect a refined data set to be available for October 2015.

Conclusions:

• The infill of the Conowingo Reservoir with the increased sediment and associated nutrient loads delivered to Chesapeake Bay creates a potential challenge in meeting the jurisdictions' Chesapeake Bay water quality standards.

• During the 2017 Midpoint Assessment decisions will be made by the CBP Partnership regarding any necessary adjustments to the Chesapeake TMDL in order to account for Conowingo Reservoir infill and offset any additional sediment and associated nutrient pollutant loads to Chesapeake Bay and their impact on the jurisdictions' Chesapeake Bay water quality standards attainment.