MEMORANDUM FOR THE RECORD

SUBJECT: Lower Susquehanna River Watershed Assessment
Quarterly Meeting, May 13, 2013

1. On May 13, 2013 agency team members met to discuss ongoing and completed activities for the Lower Susquehanna River Watershed Assessment (LSRWA). The meeting was hosted by the Maryland Department of the Environment (MDE) in their Terra Conference Room at the Montgomery Park Building in Baltimore, Maryland. The meeting started at 10:00 am and continued through 1:00 pm. The meeting attendees are listed in the table below.

2.

Lower Susquehanna River Watershed Assessment Team Meeting Sign-In Sheet			
May 13, 2013			
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Versar	Steve Schreiner		

The meeting agenda is provided as enclosure 1 to this memorandum.

Status of Action Items from February Quarterly Meeting:

a. Claire O'Neill will coordinate the next quarterly meeting for February. *Status: Done. Meeting occurring today.*

b. John Nichols will submit written comments on behalf of NMFS addressing his agency's concerns over sediment bypassing management strategy. *Status: Done. Anna Compton will distribute letter to group and have it posted on website. Bottom line of letter is that NMFS has substantial concerns about the impacts of any sediment bypassing or release options to shallow and open water habitats, including SAV and spawning grounds for fish. Chris Spaur noted that it is important to consider natural and anthropogenic status and trends of habitats and environmental conditions. Chesapeake Bay is naturally growing by hundreds of acres per year as a consequence of sea-level rise and shoreline erosion; this should be factored into considerations over impacts to shallow water and open water habitats.*

c. Danielle Aloisio will add Blackwater Wildlife Refuge as a potential placement option to evaluate. *Status: Done. See Enclosure 5.*

d. Carl Cerco will complete runs for the following scenarios: What happens when the reservoir fills? What happens when the reservoir fills and WIPs are in full effect? What is the system's condition if a large scour event occurs in spring, summer or fall? These are the final existing and future without project conditions scenarios. *Status: Complete. Carl presented this information at this meeting. See Enclosures 2 and 3 and discussion under #6.*

e. Michael Helfrich and Carl Cerco will have a follow-up phone call to discuss the estimated loads that Carl is using for his modeling efforts that will be entering the Bay once Conowingo is full and will report back to the group if these estimated loads will be revised at all. *Status: Complete. There is now agreement on estimated loads being used for modeling efforts.*

f. Matt Rowe will check in with MDE to see how sediment bypassing (for open water placement or allowing sediments to relocate to sediment-starved areas) would be permitted and the stance of his agency on permitting for such activities. *Status: Complete. Based on discussions with MDE permitting folks, they explained that if sediment bypassing were done as passive transport (e.g., via flushing, sluicing or agitation dredging instead of through a pipeline) a permit may not be required. If bypassing were actively transported via a pipeline or through a tunnel, then a permit would be required. To make any conclusive permitting decisions, more details would be required. For planning purposes for this an Assessment, we can use the assumptions laid out by MDE permitting folks. A water quality certificate and perhaps tidal wetlands permit/authorization would be required for the placement site of the material if it ended up being used as fill in the water (island, wetlands, etc.). Chris Spaur noted that USACE does not require permit for water releases from its reservoirs done as part of normal operation/maintenance activities.*

g. Pat Buckley will determine and report back to the group what the PA Department of Environmental Protection (DEP) stance is on sediment criteria for landfills ("clean" vs. "waste"). More specifically, we have data from 2000, is this too old? If so, what are expectations of the agency regarding data to determine appropriateness of sediment at a landfill? *Status: Complete. Pat provided a point of contact (Steve Socash) within PA DEP. The bottom line is that sediments from a river the size of Susquehanna can be considered, "clean" or "regulated" fill or "other waste." Per PA DEP's management of fill policy, they generally do not require chemical analysis of soils/sediments where there has not been evidence of a spill or release (i.e., these sediments could then be used in an unrestricted manner as clean fill). However, with large rivers like the Susquehanna, this would qualify as being subject to a spill or release, requiring chemical analysis to determine if clean fill requirements had been met. The 2000 sediment sampling data (averages) were compared to the concentration limits that PA DEP uses for clean fill standards: The sampled sediments meet clean fill limits for all organics and inorganics. A few parameters were not tested for in 2000 that PA DEP requires. For planning purposes, we can assume that the sediments behind the dams can be considered "clean fill" appropriate for landfill placement; however, sampling would most likely be required in the future if this option were to be implemented.*

h. The concept of a permanent pipeline should be investigated further and examples around the country should be looked at by the LSRWA agency group. *Status: Complete. Permanent pipelines are included in the LSRWA analysis. No permanent pipelines exist in Chesapeake Bay but there are examples in places like Louisiana.*

i. Michael Helfrich will forward info to Danielle Aloisio on Funkhauser Quarry. *Status: Ongoing. Bob Blama is now taking over for Danielle. Funkhauser Quarry is not on the placement option list yet. Resolution is for Bob to call the quarry.*

j. Michael Helfrich will forward Danielle Aloisio the questions he had about some of the reservoir sediment management options that were presented but could not be addressed at the meeting due to time limitations. *Status Complete.*

k. John Balay will look further into agitation dredging (coupled with electric generation releases) of fine material; it is expected this would be done outside of ecologically critical time periods. *Status Complete. See Enclosure 9 and Discussion #9.*

<u>Ongoing Action Items from Previous Meetings</u>:

A. The MDE FTP website will be utilized to share internal draft documents within the team; Matt will be the point of contact for this FTP site. *Status: Ongoing. Sharing of future documents will go through the MDE ftp website.*

B. Shawn will notify team when most recent Exelon study reports are released. *Status: Ongoing. Tom Sullivan, a contractor of Exelon noted that the Exelon has filed the license for Conowingo Dam with FERC.*

C. Anna will update PowerPoint slides after each quarterly meeting to be utilized by anyone on the team providing updates to other Chesapeake Bay groups. *Status: Ongoing.*

D. Anna will send out an update via the large email distribution list that started with the original Sediment Task Force (includes academia, general public, federal, non-government organization (NGO), and state and counties representatives) notifying the group of updates from the quarterly meeting. *Status: Ongoing.*

E. Matt will keep team informed on innovative re-use committee findings to potentially incorporate ideas/innovative techniques into LSRWA strategies. *Status: Ongoing.*

F. Anna will send out the spreadsheet tracking all stakeholder coordination to the group. Anyone making a presentation on LSRWA should let her know so the spreadsheet can be kept up to date; if any specific comments/concerns are raised, this should be noted as well. *Status: Ongoing*

G. Bruce Michael will work with CBP on potential "no-till" acres available in the watershed and evaluate impacts to sediment loads if all no-till acres were implemented in the watershed via modeling as well as develop costs. *Status: Ongoing. See discussion under #10.*

H. Carl Cerco, Steve Scott and Lewis Linker will work together to determine where nutrients are scoured from in the reservoir (at what depths) and will conduct a sensitivity analysis looking at bioavailability of nutrients in various forms (species) by Berner activity class or other means). *Status: Ongoing.*

I. Modeling efforts cannot predict impacts to SAV from physical burial by sediments. These impacts should be considered and described by other means, perhaps qualitatively, by the LSRWA agency group. *Status: Ongoing. Bruce Michael has provided the UMCES (Mike Kemp) SAV historical mapping and trends over last 10 years in Susquehanna Flats. This information will need to be incorporated into to the assessment to provide a qualitative discussion of impacts.*

J. The LSRWA agency group needs to determine next steps for developing reservoir sediment management options. *Status: Ongoing.*

K. The LSRWA agency group should quantify any habitat restored or enhanced downstream in the Bay or elsewhere (e.g., terrestrial) as a project benefit; considerations should be given on how to do this. *Status: Ongoing.*

L. Bruce Michael and Claire O'Neill will keep the LSRWA agency group updated on the Susquehanna policy group put together by Governor O'Malley. *Status: Ongoing.*

<u>Action Items from this (May 13) Quarterly meeting</u> –

a. Claire will coordinate the next quarterly meeting for August 2013.

b. Anna will distribute NMFS agency letter discussing concerns over sediment bypassing management strategy to group and have it posted on website.

c. Bob Blama will call the Funkhauser Quarry to get more information on utilizing this as a placement option.

d. Michael Helfrich will touch base with Jeff Cornwell (UMCES) to get his opinion on phosphorus bioavailability in sediments as it relates to the LSRWA study.

f. The group will review the baseline and future conditions summary spreadsheet (Enclosure 3) and provide comments back to Anna Compton and Carl Cerco.

g. Lewis Linker and Carl Cerco will work with CBP partners to integrate the CBP's assessment procedure ("Stoplight plots") into the LSRWA key modeling scenarios to provide a means to communicate/explain impacts to Chesapeake Bay from the various full reservoir and storm scouring scenarios.

h. The LSRWA agency group will develop a screening process for reservoir sediment management options that are worth developing further.

i. The LSRWA agency group will direct any questions on sediment bypass tunneling to Kathy Boomer.

j. Kathy Boomer will write up a section on sediment bypass tunneling for the LSRWA report.

k. Exelon will review and provide comments on SRBC's write-up of altering reservoir operations as a sediment management strategy (Enclosure 9). Exelon will comment on the write-up to make sure dam operations are adequately covered.

3. Welcome – After a brief introduction of the meeting attendees, Claire O'Neill welcomed the LSRWA agency group and noted that the purpose of the meeting was to provide updates on recent activities within the LSRWA.

4. Funding Update – Claire O'Neill noted that there is no FY13 federal budget yet. The Office of Management and Budget (OMB) has not released funding yet. At this time we are still using non-federal money to keep the study moving. If we don't get expected funding, we cannot complete study on time.

5. Communication and Coordination Updates – Bruce Michael let the group know that Governor O'Malley put together a high-level Susquehanna policy group with various federal and non-federal agencies. The purpose of this non-technical group is to review sediment management scenarios provided by the LSRWA group and look at funding scenarios for implementation of these scenarios. Chris Spaur asked whether this would effectively constitute a parallel effort that we need to then incorporate consideration of in the LSRWA study. Bruce said that would not be the case; the policy group would utilize what we produce.

6. Summary of Existing and Future Conditions – Carl Cerco provided a presentation on the estimated effects of scouring event on the Chesapeake Bay. Carl's presentation is included as enclosure 2 to this memorandum. It is important to note that at this time all modeling results are considered draft/preliminary and may be revised in future runs. These scenarios represent the final runs to complete all of the existing/baseline conditions and future-without-project conditions that were planned for the LSRWA effort.

The following conditions were presented:

(1) What happens when the reservoir fills?
(2) What happens when the reservoir fills and WIPs are in full effect?
(3) What is the system's condition if a large scour event occurs in spring, summer, or fall?

Utilizing ADH loads (computes sediment erosion, deposition, and transport in Conowingo Reservoir) from the application period of 2008–2011, there were two erosion (scouring) events: Tropical Storm Lee and a small event in March 2011. There are three ADH runs based on 2008–2011 hydrology:

(1) existing (2011) bathymetry,
(2) projected "reservoir full" bathymetry, and
(3) bathymetry surveyed following 1996 scour event.

Carl used scour computed by ADH 2008–2011 to estimate scour during the January 1996 storm which falls in the Chesapeake Bay Environmental Model Package (CBEMP) application period, 1991–2000.

Carl noted that as of 2011, the reservoir is virtually full. However, even when the reservoir is full, it still appears to be depositing under non-scouring flows. Under normal hydrologic conditions (non-scouring), sediment that flows into reservoir system does not necessarily leave the reservoir system and flow into Chesapeake Bay. What we see are events. Erosion events are becoming more frequent with more material. The reservoir tends to mitigate itself. When a scour event happens, more room is made available in the reservoir for deposition.

Carl discussed the water quality implications next. His modeling predicts what happens in the Bay if watershed implementation plans (WIPS) are in place, reservoir is full and there is a storm event. As in past modeling runs, monitoring station CB3.3C is where he looks at water quality impacts. This site is used because it sits at the head of the deep trench that runs up the center of most of the bay. It is a critical location for water quality conditions. In particular, the bottom is virtually anoxic in summer. The Total maximum daily loads (TMDLs) hinge on meeting DO standards in bottom waters in the vicinity of CB3.3C. Consequently, changes in DO at this location are critical compared to changes to other monitoring stations closer to Conowingo where DO is usually in excess of standards. In addition to DO concerns, CB3.3C has elevated chlorophyll concentrations and is just downstream of the turbidity maximum so it is a good station to characterize the upper bay water quality. He noted that as a storm goes by, they produce an enormous temporary spike in solids in the water column (solids are materials like sand, silt, and clay) but they are inert after deposition on the bottom and don't cause further water quality impacts. Light attenuation impacts are short-lived. Nutrients from the scouring event are recycled and there impacts persist for years. Lewis Linker asked about nutrient loads. Carl noted that he evaluated nutrients based on Tropical Storm Lee (2011). The 1996 storm event nutrient composition was different than Tropical Storm Lee (i.e., percentages of nutrients associated with solids varied). Carl noted that implications of this are that we may be overestimating nutrient loads from 1996 event by a factor of 2. We will need to acknowledge this level of uncertainty in the LSRWA report.

Carl then went over modeling results looking at the timing of a storm event. The Chesapeake Bay Program (CBP) modified the Hydrological Simulation Program--Fortran (HSPF) to produce storm scour consistent with the latest USGS estimates. Also, CBP has produced hydrodynamics and watershed model (WSM) runs that move the 1996 storm to different months (spring and summer). Utilizing HSPF and CBP WSM allows Carl to look at runoff and scour. Carl made runs using the scour conditions from the January 1996 storm: (1) winter storm; (2) storm moved to June; and (3) storm moved to October. Carl noted that he looked at the impacts of the entire storm event, not just scouring. What you see is a pulse (the impact of the storm passing). There is a big pulse in January but the impact on light is negligible. An October storm appeared to have minimal impacts. Even in June long-term impacts appeared negligible; impacts appeared short-lived. A June event has the most observed effects.

Lew Linker noted that the results may not represent effects on SAV; a period of reduced light could really impact SAV. Carl noted that for the final report these final outputs need to be remedied. There is an interesting spatial extent of chlorophyll; during a January event, impacts are seen all the way to the mouth of Potomac; in June, the spatial extent goes further south to the mouth of the Rappahannock. There was discussion on nitrogen (N) and phosphorus (P) loads. We have N loads delivered from the storm runoff, minimal from scour of bottom sediment in Conowingo Pond. We don't have information on the specific N and P amounts, just a percent of the total loads. Bioavailability of these nutrients is important information. There was discussion that Jeff Cornwell (UMCES) has some numbers on P and bioavailability. Michael Helfrich noted that he has had discussion with Jeff Cornwell and will discuss with him further his opinion and what data he has readily available that we may be able to use to allow us to make some assumptions to refine amount of phosphorus that are bioavailable in sediments. Chris Spaur noted that collecting biogeochemical data to fill information voids was considered during study scoping, but eliminated in order to control overall study costs.

Anna Compton passed out a spreadsheet that recaps all six baseline and future conditions modeling runs that Carl Cerco has evaluated. This spreadsheet is included as enclosure 3 to this memorandum. For each condition, modeling runs were made based on varied land use, hydrology, bathymetry and scouring, and the effects to water quality as well changes to sediment and nutrient loads that were observed. There was not much time to go over the spreadsheet so the group needs to review and provide written comments back to Anna and Carl Cerco. There was discussion on Condition 3 (system condition when WIPs are in full effect, reservoirs are still trapping and a scour event occurs) in comparison to Condition 5 (system condition when WIPs are in full effect, reservoirs are full and a scour event occurs). It appears that these conditions have similar effects to water quality and sediment nutrient loading. There was discussion on benefit versus cost. Based on what was presented, it appears from the modeling that there is not much difference in effects whether the reservoir is completely full or in its current nearly full condition. Does this lead us to the conclusion that if we try to increase capacity by minor amounts, we will not see much benefit? What about maintaining status quo? Is it worth the investment? What are we going to get for reducing sediment volume?

To further understand modeling predictions and their impacts, there was discussion on stoplight plots that the CBP has developed. This is a CBP assessment procedure that analyzes the impacts of load scenarios on water quality of a Bay segments and whether they reach attainment or not (meeting TMDLs). Lewis Linker noted that we would probably want to run all of our key LSRWA scenarios (conditions) using the stoplight plots to show the effects to water quality by bay segment with the predictions of Carl's model.

Michael Helfrich noted that Carl's modeling is using the 4th biggest event we have on record to show storm scouring (the 1996 winter storm event). What about the storms that have occurred on record that were larger than this event? Also the loads (nutrient and solids) shown in Condition 6 (scour event in summer, fall, and winter) are less than loads in Conditions 3-5, which all included a simulation of the same storm event; why is this? Carl explained that Condition 6 used HSPF and CBP WSM model (which can take into account sediments from the watershed as well) while Conditions 3-5 used the ADH model, so results vary and should not be compared directly. Condition 6 sheds light on impact of the timing of event while Conditions 2-5 show impacts of a full reservoir, WIPs in place, and a storm event.

There was discussion about Condition #2 (What is the system's condition if the WIPs are in full effect and reservoirs are still trapping) in that the loads on Carl's spreadsheet appear smaller than the loads full implementation of the PA WIPS (per TMDL) will obtain. For example Carl predicts the average solids load over the 10-yr period) is 2,307 metric ton/d but the TMDL is 2,417 metric tons/day; Carl predicts the average nitrogen load is 46.1 metric ton/d, while TMDL is 93.2 metric tons/day; Carl predicts phosphorus is 3.9 metric tons/d, while TMDL is 4.25 metric tons/day Carl will check spreadsheet/loads to clarify modeling predictions..

Herb has concerns about communicating this information to the general public. Up until now, the public information has been that the dam is trapping and it will eventually fill, but once it fills we will see more nutrients and sediment in Chesapeake Bay. We need to be clear on what the models are predicting. There was discussion on the concept model Carl presented (slide 5 of Enclosure 2), showing that scouring of reservoirs is negative to water quality in Chesapeake Bay; however, scouring does create capacity behind the dams to keep sediments and nutrients out of Chesapeake Bay for a period of time.

7. Update on Reservoir Sediment Management Scenarios –

Bob Blama provided a presentation on USACE's analysis of reservoir sediment management scenarios. This was a follow-up to what was presented at the February quarterly meeting. Tom Laczo provided a handout which lays out the placement options for dredged material that have been evaluated thus far. This was also an update to what was presented at the February quarterly meeting. Bob's presentation is included as enclosure 4, and the placement options handout is included as enclosure 5 to this memorandum. Bob also provided two handouts, one describing hydraulic and mechanical dredging, and the other describing the process of drying dredged material for placement (i.e., dewatering). These are included as enclosures 6 and 7 to this memorandum.

Tom noted that placement options have been organized into three categories: (1) beneficial use, (2) open water, and (3) upland. Every placement option has pros and cons which are listed in the table in regards to feasibility, environmental impacts and costs.

Bob walked the group through the various placement site possibilities for sediments behind the dams and the differences between hydraulic and mechanical dredging. He noted that he did not recommend island creation (tear drop islands) and fringe wetland creation in the Susquehanna River because they would not be able to use the volume of sediments we are looking at for placement. To pump downstream, we would need to pump for several months to remove material. In discussions with abandoned mine owners, there was not an interest in the material because of limitations on their mining permits. In doing an informal screening, not many placement options are left. Quarries seem to be feasible. We also need to think about a placement site to dewater the material. If you need to hydraulically pump material more than 5 miles, you will need a booster which adds to the project cost. When transporting material, considerations such as topography of the land come into play; for example, material is easier to pipe over flat versus hilly land. At Conowingo, the topography out of reservoir is uphill.

There was discussion on the large number of reservoir sediment management scenarios/alternatives we have. We need to work on screening these.

8. <u>Sediment Bypass (Tunneling) Strategies</u>

Kathy Boomer provided the group an overview of sediment bypass (tunneling) strategies. Her presentation is included as enclosure 8 to this memorandum.

This technology has been implemented in places like Japan and Switzerland, in the form of bypassing sediments downstream or to a placement site, via a tunnel. With this technology, there is a lot of control on the size of material that you are targeting to move. There are yearly maintenance costs to repair these tunnels. Advantages are that it is a long-term sediment management solution to extend the storage capacity of reservoirs. Disadvantages are that it is does not provide a solution for already stored sediments (it moves sediments that have not deposited yet), the technology is still in development, and it appears very costly. However, it is difficult to fully estimate costs due to the limited use of this technology.

The use of bypass tunnels depends on your goals. For example, entities that have looked at implementing or have implemented bypassing tunnels, normally have a goal of extending the life of water storage capacity in the reservoir, protecting turbines or restoring sediment supply for downstream habitat value. For the LSRWA study, the goal is protection of downstream water quality. In the short-term, bypass tunnels do not offer much in meeting our goals. Scour events are still likely to occur. A sediment bypass tunnel system likely will not offer much more benefit from "run-of-river" equilibrium conditions. After a scour event, however, a long-term management strategy could be implemented with a sediment bypass tunnel with delivery of a more desired sediment composition to the downstream area.

For the LSRWA report, Kathy Boomer will write up the section on sediment bypass tunneling.

9. <u>Update on Reservoir Operational Strategies-</u>

John Balay provided the group an update on reservoir operational sediment management strategies. He provided a handout with a write-up describing and summarizing implementation considerations and constraints, and conclusions regarding the utilization of reservoir operations to manage sediment in the lower Susquehanna River which is included as enclosure 9 to this memorandum.

John analyzed altering the structure of the three hydroelectric dams on the lower Susquehanna River to meet the LSRWA sediment management goals. None of the three hydroelectric dams currently contain outlet works that would permit sediment releases during favorable hydrologic conditions.

He explained that release of sediment through the turbines, in excess of what is transported normally during generation operations at higher streamflows could cause significant damage to the existing structure (Note that following the quarterly meeting, Exelon representatives indicated that the potential for turbine damage may not be that significant). Existing gates at Safe Harbor and Conowingo are designed for flood operations and, as such, provide little opportunity for sediment management. Retrofitting the existing dam structures with sluice gates or other bottom outlet works would be difficult without compromising the dams' structural integrity.

Many of the sediment management strategies that alter operations would significantly impact power generation and water supply operations.

Of the various methods to manage sediments via altering the operations of the reservoir, agitation dredging garnered the most discussion. This type of dredging includes the removal of bottom material from a selected area by using equipment to raise it temporarily in the water column and currents to carry it away. Agitation dredging could be considered an operational alternative when conducted in conjunction with typical or modified dam operations. This particular operation would focus on fine sediments typically concentrated in downstream portions of each of the lower Susquehanna River reservoirs. The bulk of agitated suspended bed sediment would be in the lower half of the water column. To transport the suspended material, hydropower intakes would need to be open at the highest flow possible, which is 86,000 cfs (cubic feet per second) at Conowingo. At this hydraulic capacity, it is unlikely that there would be adequate flow velocity in the lower portions of the reservoirs to transport agitated sediment. Also, there was discussion on dredging being dangerous if we agitate during high flows.

The cumulative effect of competing water uses, operational limitations, and structural constraints make altering reservoir operations very difficult, for sediment management. That coupled with the limited spatial and volumetric effects of sediment movement do not justify the significant implementation costs required. John concluded that the combination of these factors warrant that reservoir operations alternatives be dropped from further consideration.

Any further comments to these operational strategies should be sent to John. In particular, Exelon the owner and operator of Conowingo will comment on the write-up to make sure that the dam operations are adequately covered.

10. Update on Watershed Sediment Management Strategies-

Bruce Michael provided the group an update on the development of watershed sediment management strategies. Bruce noted that when it comes to watershed sediment management strategies, the most cost-effective best management practice (BMP) according to CBP is "no till" agriculture. Bruce noted that he is continuing to investigate this BMP for the LSRWA effort. The idea is to go above and beyond what the states are doing with WIPs to meet the TMDLs. The specific scenario he is investigating is the "maximum feasible" scenario in the watershed, that is, what is the maximum feasible amount of acres that could be implemented, what would it cost, and what would the impacts be to sediments. An analysis needs to be done on cost and acres available in the watershed to implement this type of strategy. Bruce noted that implementation costs won't be released until next winter by CBP. He could work with CBP to get preliminary numbers for inclusion in the LSRWA analysis. BMP efficiency numbers already exist. For LSRWA effort we would focus on the most efficient BMP to reduce sediment. There was a discussion on population growth (i.e., acres available now may not be available years down the road due to development). This analysis includes acres available right now. Claire noted that we need costs and acres developed in the next few weeks. In June we are scheduled to develop and decided what sediment management modeling scenarios what we want to run for LSRWA effort.

11. <u>WIP Scenarios and Nutrient Loads –</u>

Lewis Linker provided the group an update on WIP scenarios and nutrient loads that CBP is working on. He provided a presentation which is included as enclosure 10 to this memorandum. Lewis noted that the sediment loads predicted from CBP modeling are changing all the time but do have long-term trends. He discussed loads from the watershed model (WSM) version 5.3.2 and discussed four scenarios. The 1985 "High Historical Load Scenario" uses 1985 land uses, animal numbers, atmospheric deposition, point source loads and a 10-year (1991–2000) hydrology. This scenario has the highest historical delivered load estimates of nutrients and sediment to the Bay. The "2011 Progress Scenario" uses 2011 land uses, animal numbers, atmospheric deposition, point source loads and the 10-year, 1991–2000 hydrology. The "2010 WIP" scenario estimates the nutrient and sediment loads with 2010 WIPs throughout the Chesapeake Bay watershed. The scenario included accounting for all the WIP BMPs based on a 2010 land use, permitted loads and atmospheric deposition. The "All Forest Scenario" uses an all-forest land use and current estimated atmospheric deposition loads for the 1991–2000 period and represents estimated loads with maximum reductions on the land. This scenario has loads greater than a pristine scenario, which would have reduced atmospheric deposition loads.

Lew presented loads (total phosphorus, total nitrogen, and total suspended solids) from each of these scenarios at the Conowingo and Marietta monitoring stations. The 1985 scenario had the highest predicted loads for all three parameters, followed by the 2011 progress scenario, the 2010 WIP scenario and finally the all forest scenario.

12. <u>Alternatives Framework</u>

Claire provided a handout which is a flowchart that lays out a framework of sediment management alternatives to assist the LSRWA team with organizing the large amount of sediment management alternatives involved in this study. This handout is included as enclosure 11 to this memorandum. Ideally each representative sediment management alternative would have a cost associated with it as well as volume of sediment that could be removed/moved ($/cubic yard).

13. <u>Wrap Up</u> –

Anna will draft up notes for the group's review. Following this, the notes and presentations will be posted to the project website. Claire will set up a doodle poll to determine the date for next quarterly meeting which will be sometime in August.

Anna Compton,
Study Manager/Biologist

Enclosures:
1. Meeting Agenda
2. Summary of Existing and Future Conditions- Carl Cerco Presentation

3. Baseline and Future Conditions spreadsheet.
4. Reservoir Sediment Management Options – Bob Blama Presentation
5. Lower Susquehanna Placement Options Handout
6. Dredging Handout
7. Dewatering/Drying Handout
8. Sediment By-pass tunnels–Kathy Boomer Presentation
9. Altering Reservoir operations handout
10. WIP Scenarios and Nutrient Loading -Lewis Linker Presentation
11. Sediment Management Alternatives Framework

LOWER SUSQUEHANNA RIVER WATERSHED ASSESSMENT
QUARTERLY TEAM MEETING

MDE Aqua Conference Room, Baltimore, Maryland
May 13, 2013

Meeting Agenda

		Lead
10:00	Welcome and Introductions	All
10:05	Review of Action Items from Prior Meetings Funding Update Communication and Coordination Updates for Situational Awareness Conowingo Policy Group Meeting on 22 April 2013	O'Neill

LSRWA Technical Analyses

10:20	Summary of Existing and Future Conditions	Cerco/Comption
10:50	Update on Reservoir Sediment Management Strategies	Blama/Laczo
11:20	Sediment Bypass Strategies	Boomer
11:35	Update on Reservoir Operational Strategies	Balay
11:45	No-Till Acreage Strategy	Michael
11:55	WIP Scenarios and Nutrient Loads	Linker
12:15	Alternatives Framework	Compton/O'Neill
12:25	Meeting Wrap-Up Action Items/Summary/Schedule Ahead Next Meeting	O'Neill

Call-In Information: (877) 336-139, access code = 6452843#, security code = 1234#

Expected Attendees:

MDE: Herb Sachs; Tim Fox, Matt Rowe
MDNR: Bruce Michael, Bob Sadzinski, Shawn Seaman
MGS: Jeff Halka
SRBC: John Balay, Andrew Gavin, Dave Ladd
USACE: Anna Compton, Bob Blama, Chris Spaur, Claire O'Neill, Tom Laczo, Dan Bierly
ERDC: Carl Cerco, Steve Scott
TNC: Mark Bryer, Kathy Boomer
USEPA: Gary Shenk, Lewis Linker
USGS: Mike Langland, Joel Blomquist

Exelon: Mary Helen Marsh, Kimberly Long, Gary LeMay
Lower Susquehanna Riverkeeper: Michael Helfrich
PA Agencies: Patricia Buckley, Raymond Zomok

Action Items from February 2013 Quarterly Meeting:

a. Claire will coordinate the next quarterly meeting for May.

b. Anna will send out the spreadsheet tracking all stakeholder coordination to the group. Anyone making a presentation on LSRWA should let her know so the spreadsheet can be kept up to date; if any specific comments/concerns are raised, this should be noted as well.

c. John Nichols will submit written comments on behalf of NMFS addressing his agency's concerns over sediment bypassing management strategy.

d. Danielle will add Blackwater Wildlife Refuge as a potential placement option to evaluate.

e. Bruce will work with Gary on potential "no-till" acres available in the watershed and evaluate impacts to sediment loads if all no-till acres were implemented in the watershed via modeling.

f. Carl will complete runs for the following scenarios: What happens when the reservoir fills? What happens when the reservoir fills and WIPs are in full effect? What is the system's condition if a large scour event occurs in spring, summer or fall? These are the final existing and future without project conditions scenarios.

g. Carl, Steve and Lewis will work together to determine where nutrients are scoured from in the reservoir (at what depths) and will conduct a sensitivity analysis looking at bioavailability of nutrients in various forms (species) by Berner activity class or other means).

h. Michael and Carl will have a follow-up phone call to discuss the estimated loads that Carl is using for his modeling efforts that will be entering the Bay once Conowingo is full and will report back to the group if these estimated loads will be revised at all.

i. Modeling efforts cannot predict impacts to SAV from physical burial by sediments. These impacts should be considered and described by other means, perhaps qualitatively, by the LSRWA agency group.

j. Matt will check in with MDE to see how sediment bypassing (for open water placement or allowing sediments to relocate to sediment-starved areas) would be permitted and the stance of his agency on permitting for such activities.

k. Pat will determine and report back to the group what the PA department of Environmental Protection (DEP) stance is on sediment criteria for landfills ("clean" vs. "waste"). More specifically, we have data from 2000, is this too old? If so, what are expectations of the agency regarding data to determine appropriateness of sediment at a landfill?

l. The concept of a permanent pipeline should be investigated further and examples around the country should be looked at by the LSRWA agency group.

m. Michael will forward info to Danielle on Funkhauser Quarry.

n. Michael will forward Danielle the questions he had about some of the reservoir sediment management options that were presented but could not be addressed at the meeting due to time limitations.

o. The LSRWA agency group needs to determine next steps for developing reservoir sediment management options.

p. John Balay will look further into agitation dredging (coupled with electric generation releases) of fine material; it is expected this would be done outside of ecologically critical time periods.

q. The LSRWA agency group should quantify any habitat restored or enhanced downstream in Bay or elsewhere (e.g. terrestrial) as a project benefit; considerations should be given on how to do this.

<u>Ongoing/Action Items from Previous Meetings</u>:

a. The MDE FTP website will be utilized to share internal draft documents within the team; Matt will be the point of contact for this FTP site. *Status: Ongoing. Sharing of future documents will go through the MDE ftp website.*

b. Shawn will notify team when most recent Exelon study reports are released. Status: *Ongoing. Tom Sullivan, a contractor of Exelon noted that the Exelon has filed the license for Conowingo Dam with FERC.*

c. Anna will update PowerPoint slides after each quarterly meeting to be utilized by anyone on the team providing updates to other Chesapeake Bay groups. *Status: Ongoing.*

d. Anna will send out an update via the large email distribution list that started with the original Sediment Task Force (includes academia, general public, federal, non-government organization (NGO), and state and counties representatives) notifying the group of updates from the quarterly meeting. *Status: Ongoing.*

e. Matt will keep team informed on innovative re-use committee findings to potentially incorporate ideas/innovative techniques into LSRWA strategies. *Status: Ongoing.*

f. Michael Helfrich will coordinate with MD, Chesapeake Bay Program (CBP) and the MD county coalition to set up a meeting to present dam implications to total maximum daily loads (TMDL) to MD counties. *Status: Ongoing. Michael Helfrich coordinated this task with Bruce Michael; Bruce has reported LSRWA activities to multiple groups and counties over the last 6 weeks. His message to counties was to keep in perspective that they still need to do their work regarding sedimentation from the watershed (meeting TMDLs) while the issue of sediments and nutrients trapped behind the dams and how to manage them are still being dealt with. Bruce noted that Bob Summers, MDE Secretary, has made presentations to the MD legislative committees as well.*

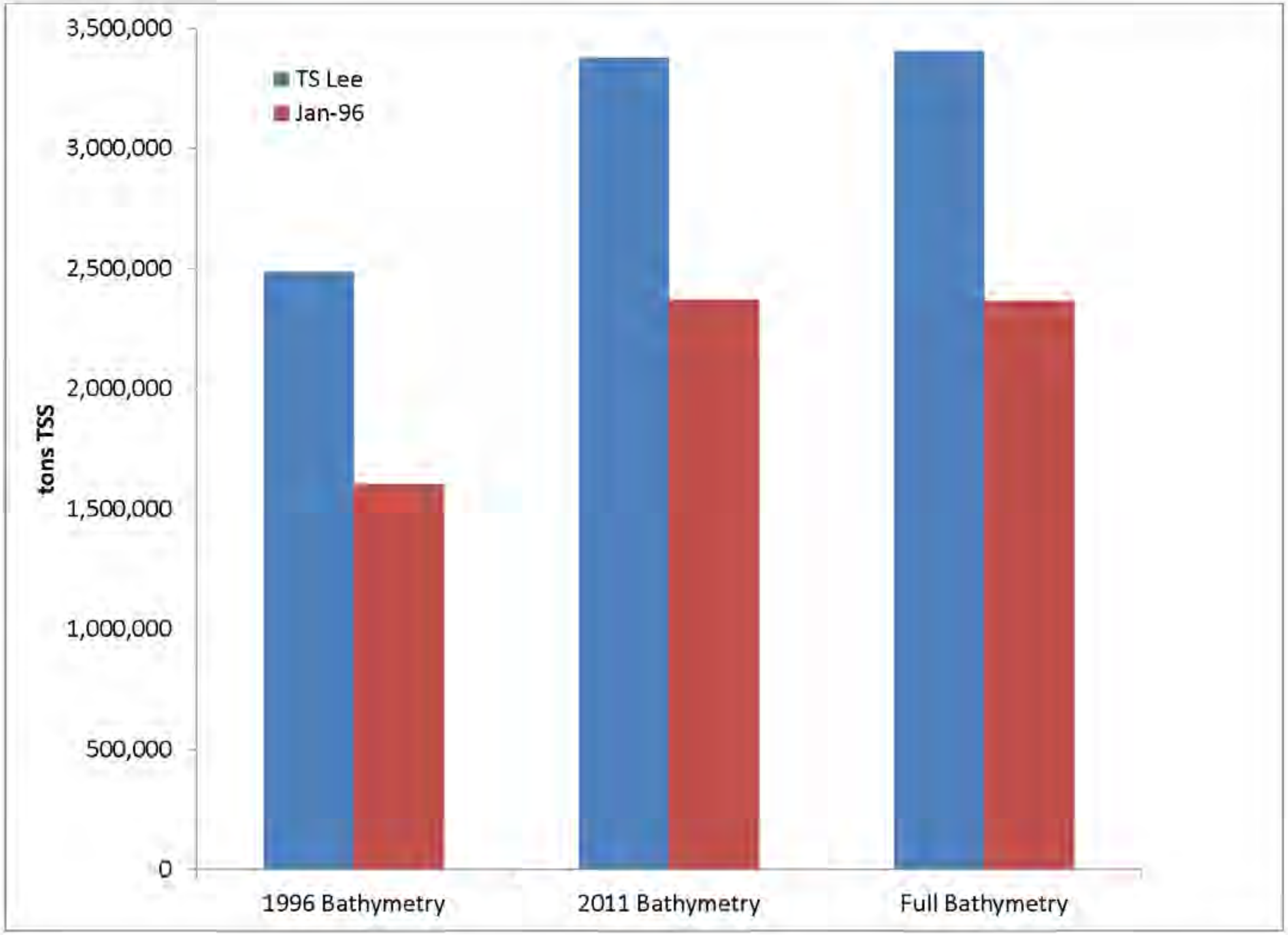
Actions Items from February

1. What happens when the reservoir fills?
2. What happens when the reservoir fills and WIPS are in full effect?
3. What is the system’s condition if a large scour event occurs in spring, summer, or fall?

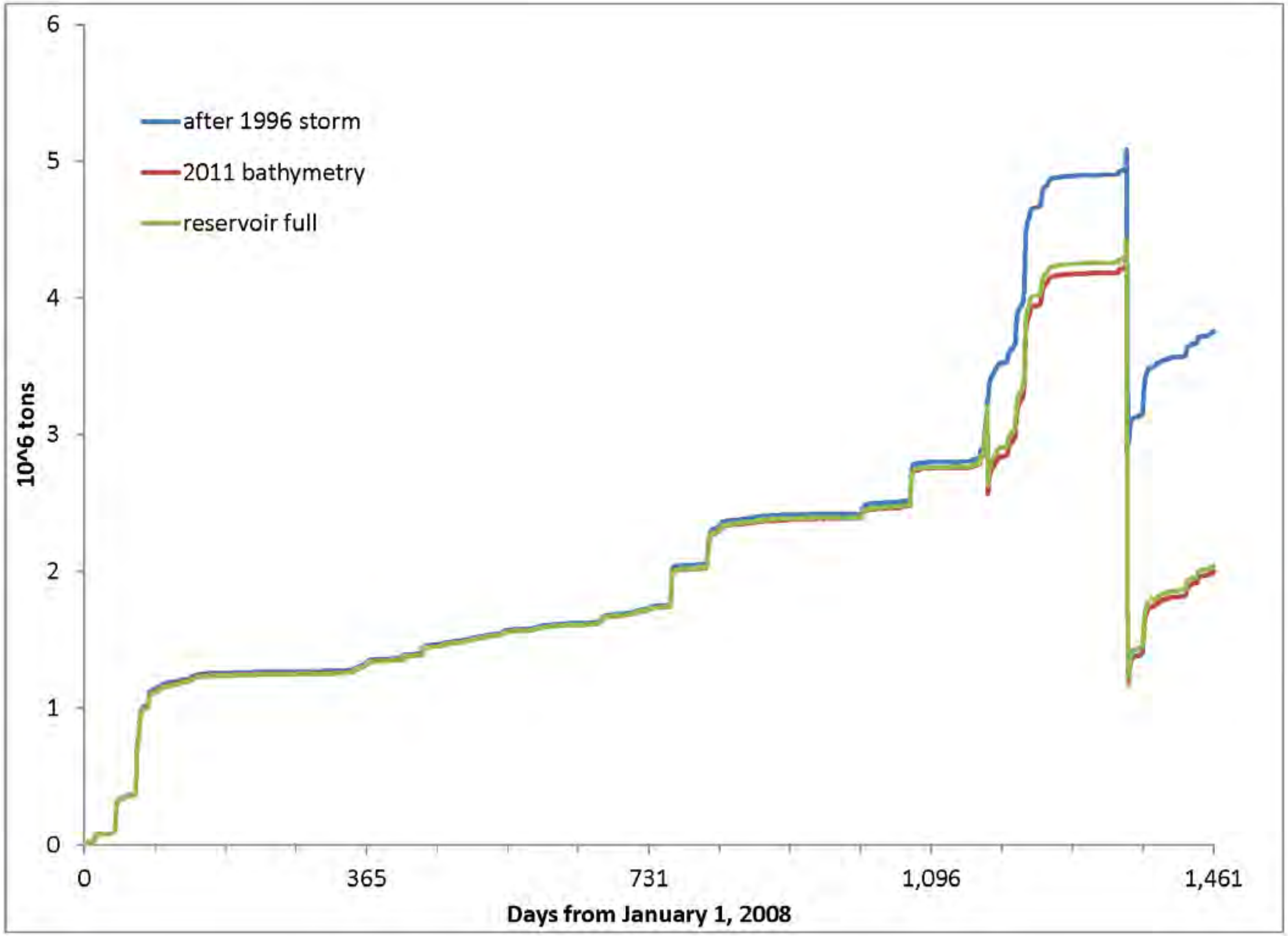
Background

- ADH is the premier tool for computing sediment erosion, deposition, and transport in Conowingo Reservoir.
- The ADH application period, 2008 – 2011, contains two erosion events: Tropical Storm Lee and a small event in March 2011.
- We have three ADH runs based on 2008 – 2011 hydrology:
  - Existing (2011) bathymetry,
  - Projected “Reservoir Full” bathymetry,
  - Bathymetry surveyed following 1996 scour event.
- We are using scour computed by ADH 2008 – 2011 to estimate scour during the January 1996 storm which falls in our CBEMP application period, 1991 – 2000.

TSS Scour from ADH

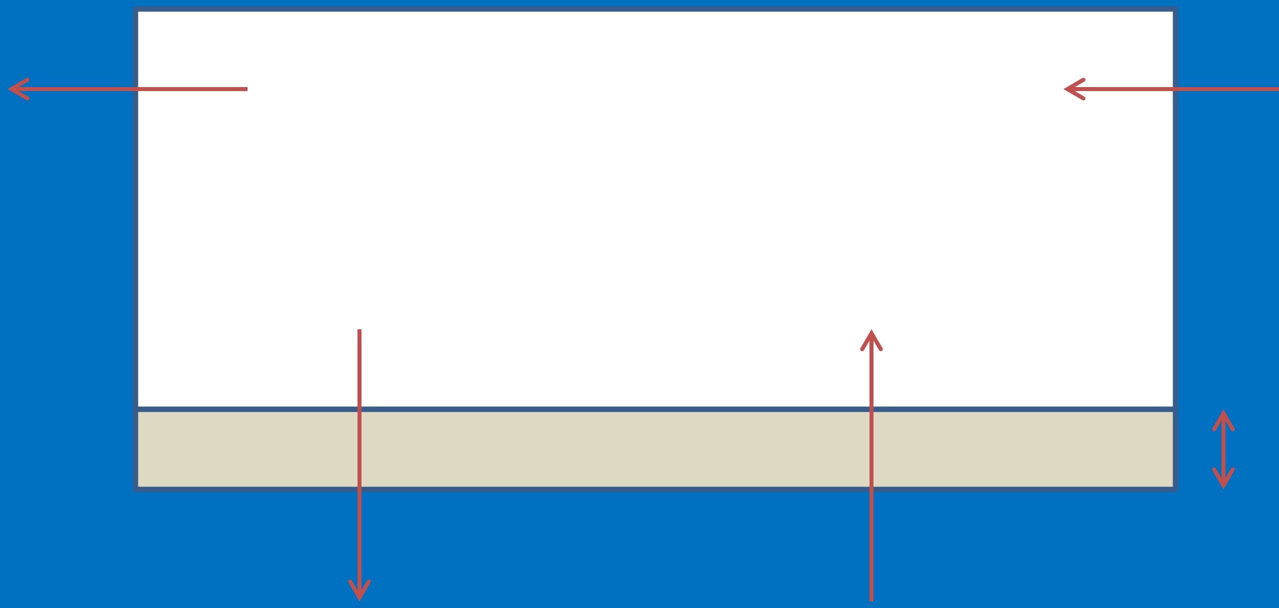


Cumulative Deposition



Conceptual Model

Sediment and nutrient releases are event-oriented.



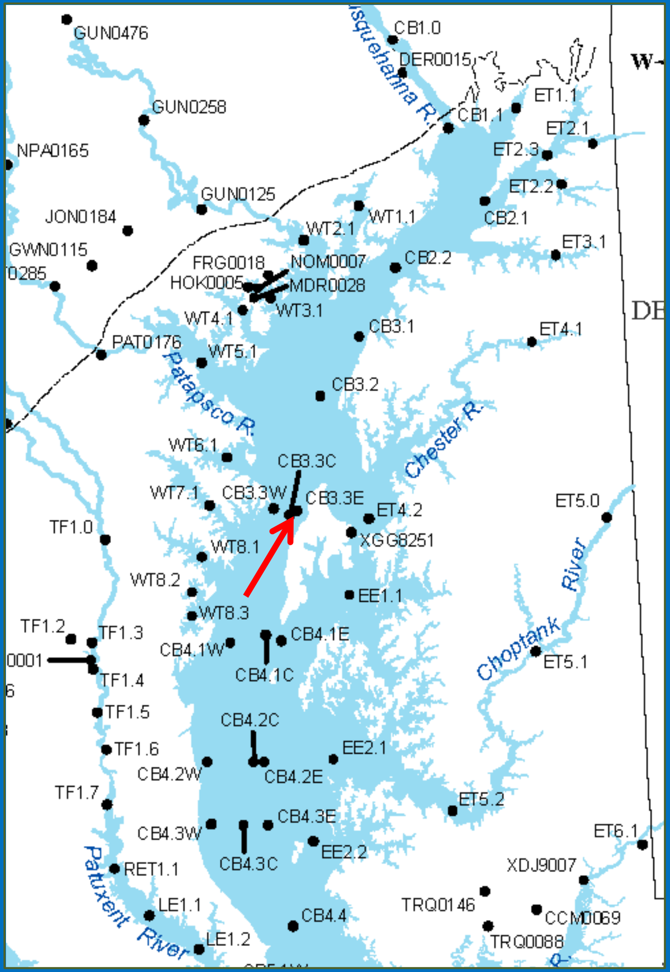
WIPS decrease sediment loads. Also decrease deposition.

Erosion event increases depth, diminishes subsequent erosion events.

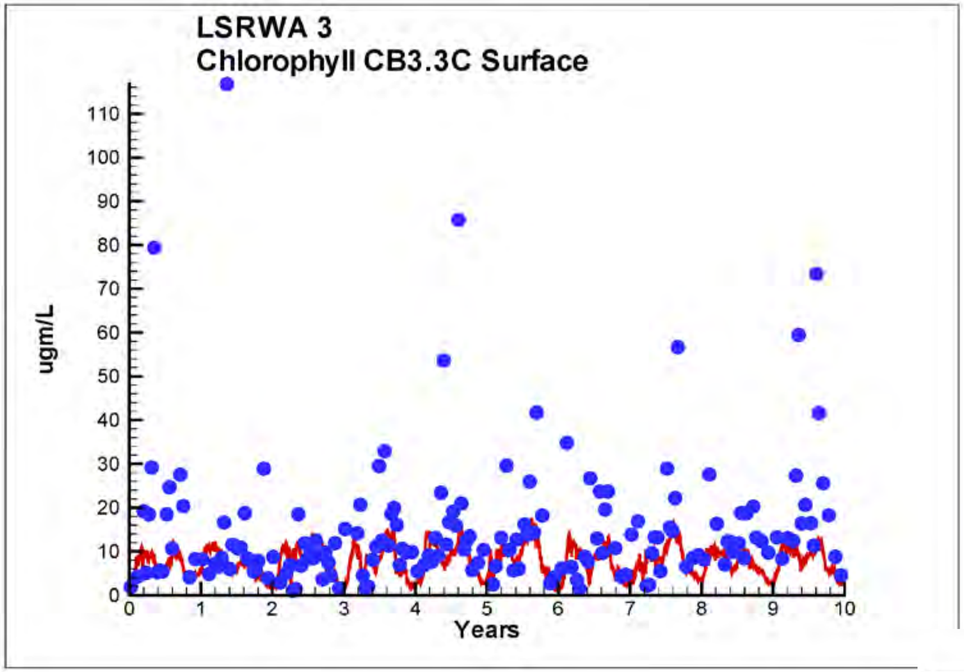
Sedimentation rate is largely independent of bathymetry.

Scour is strongly dependent on bathymetry.

Model Results

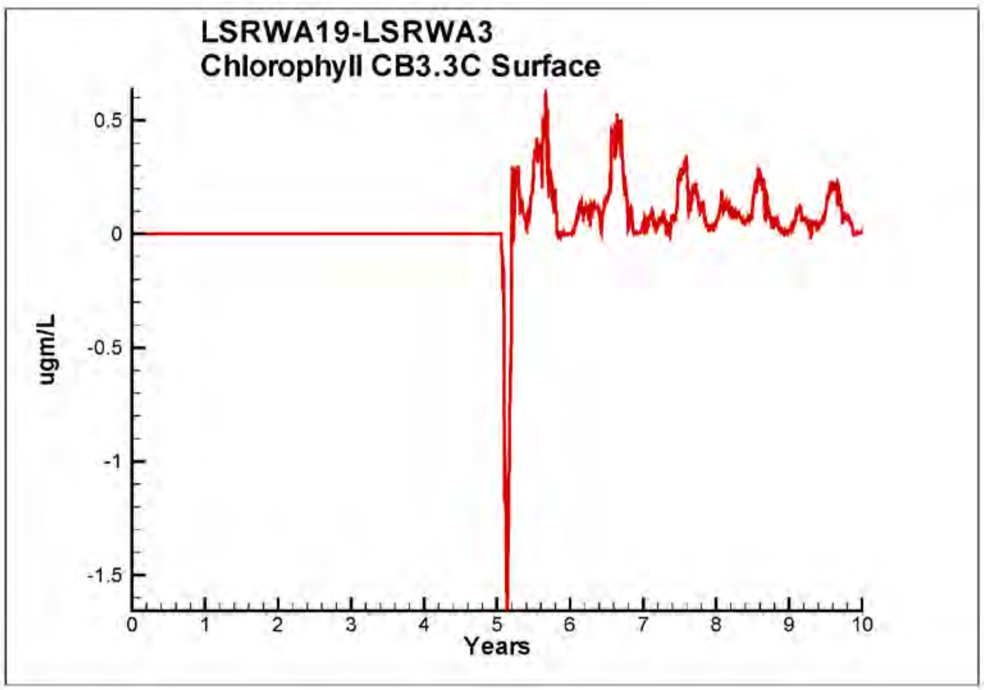


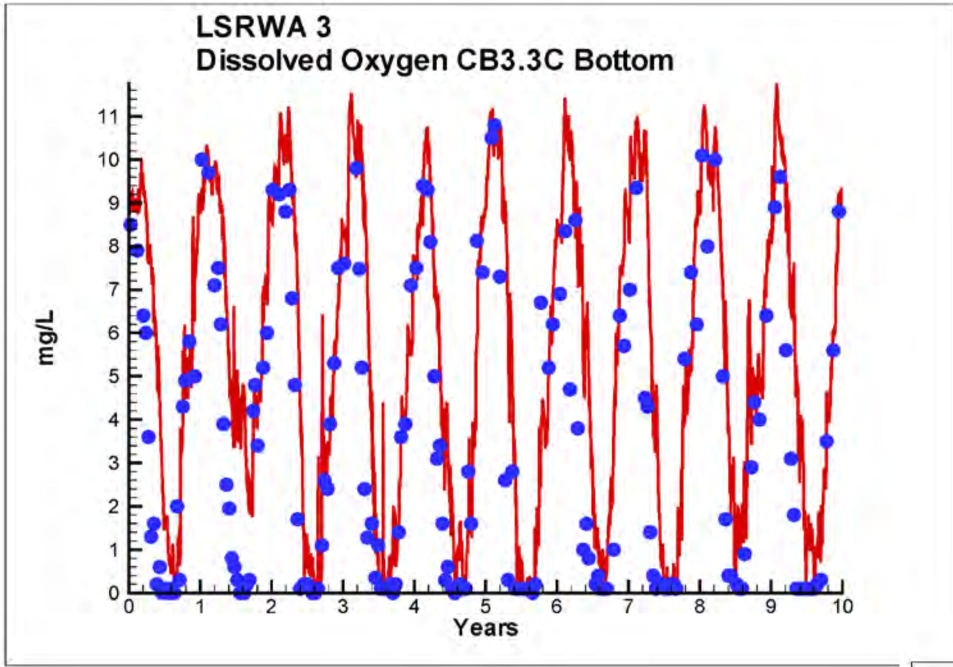
- Let's concentrate on the TMDL (WIP) run.
- We'll look at time series at CB3.3C and at longitudinal plots in summer 1996 (first summer after storm).



Base TMDL simulation shown in red.

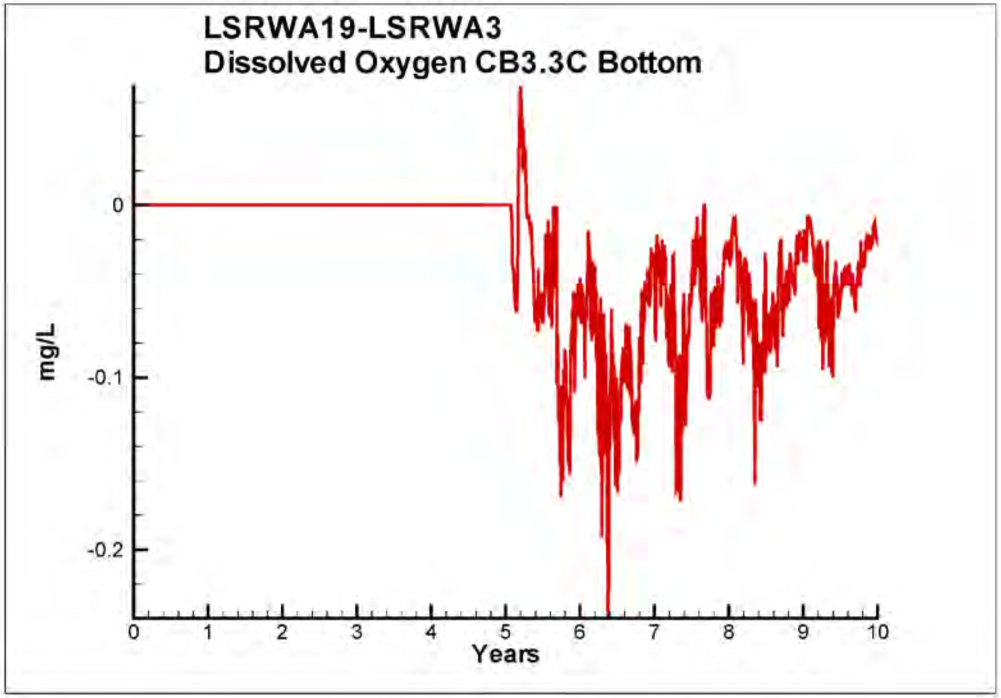
Difference plot showing effect of storm scour.

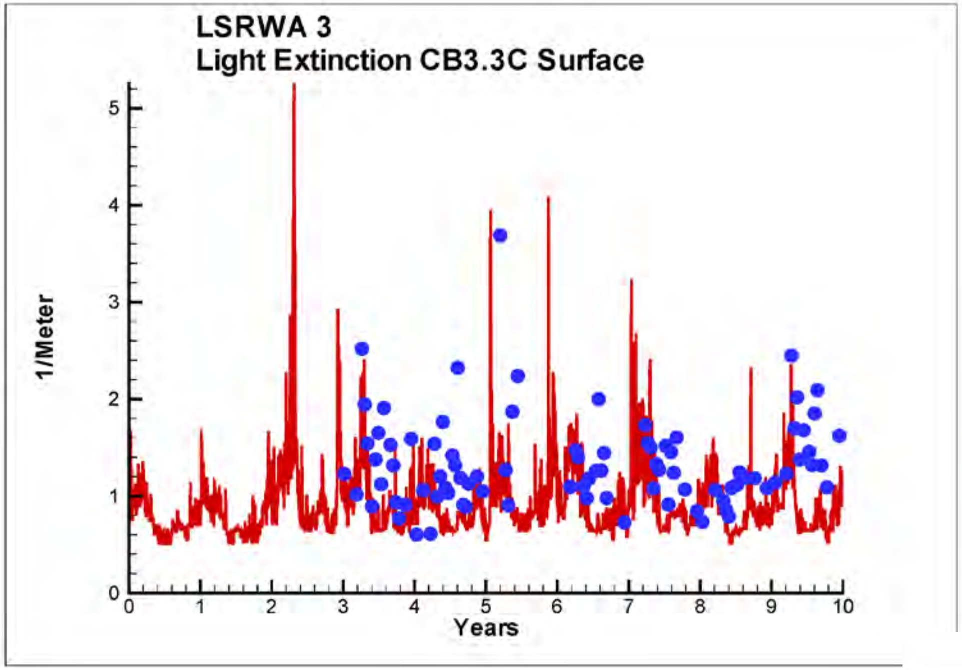




Base TMDL simulation shown in red.

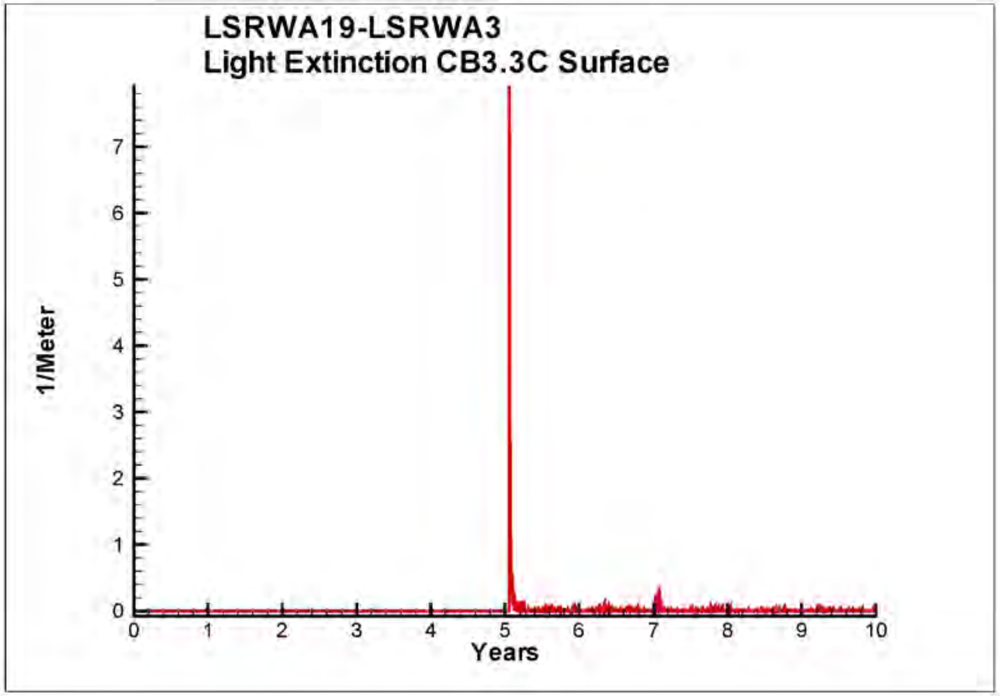
Difference plot showing effect of storm scour.

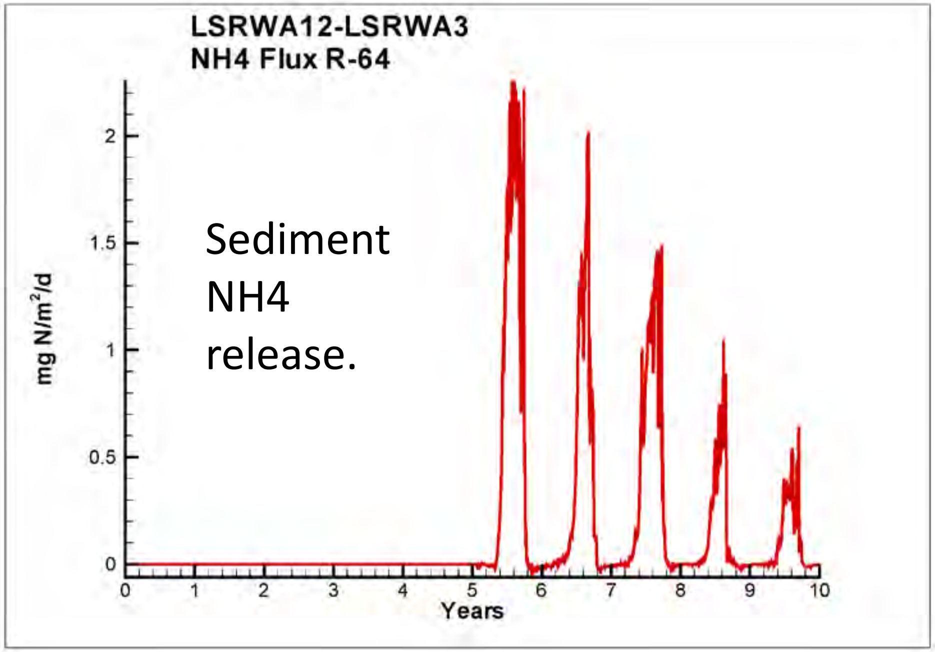




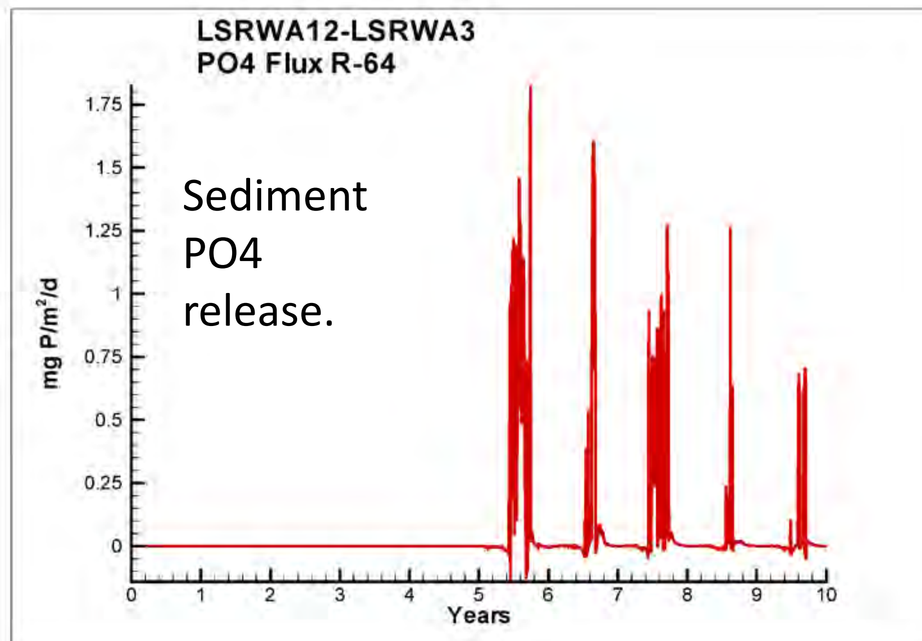
Base TMDL simulation shown in red.

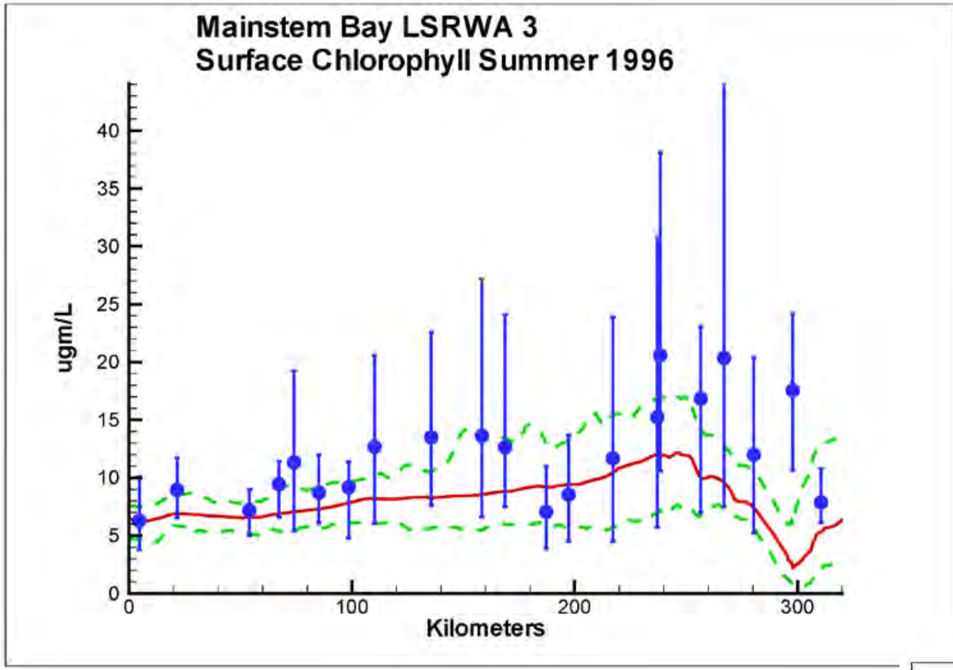
Difference plot showing effect of storm scour.





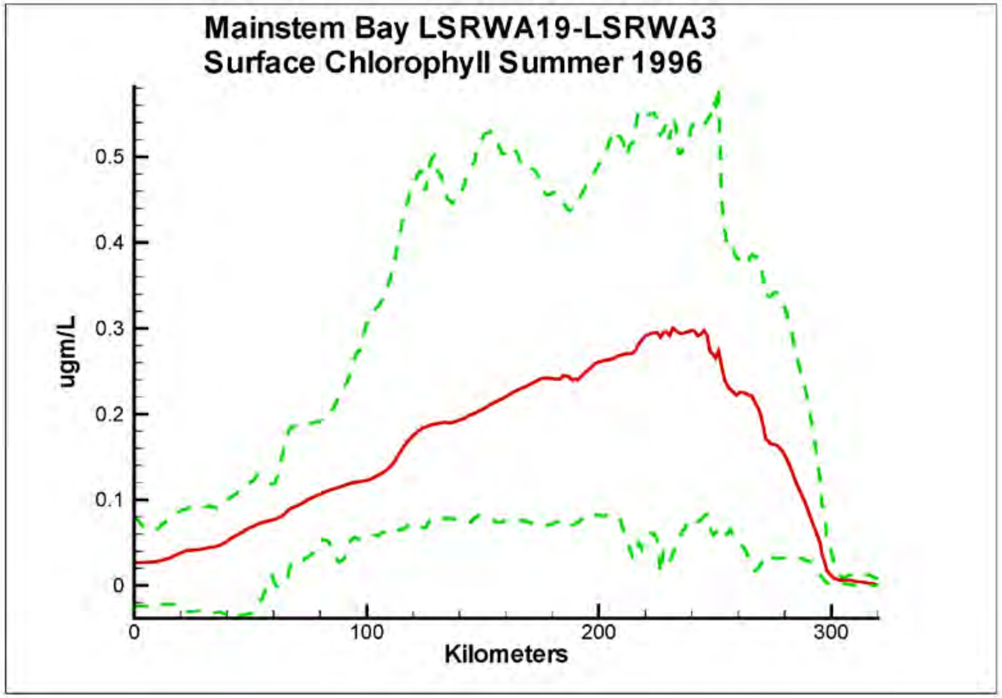
What's happening? Nutrients from the scour event deposit in bottom sediments and persist for years. Solids from scour event are inert after deposition.

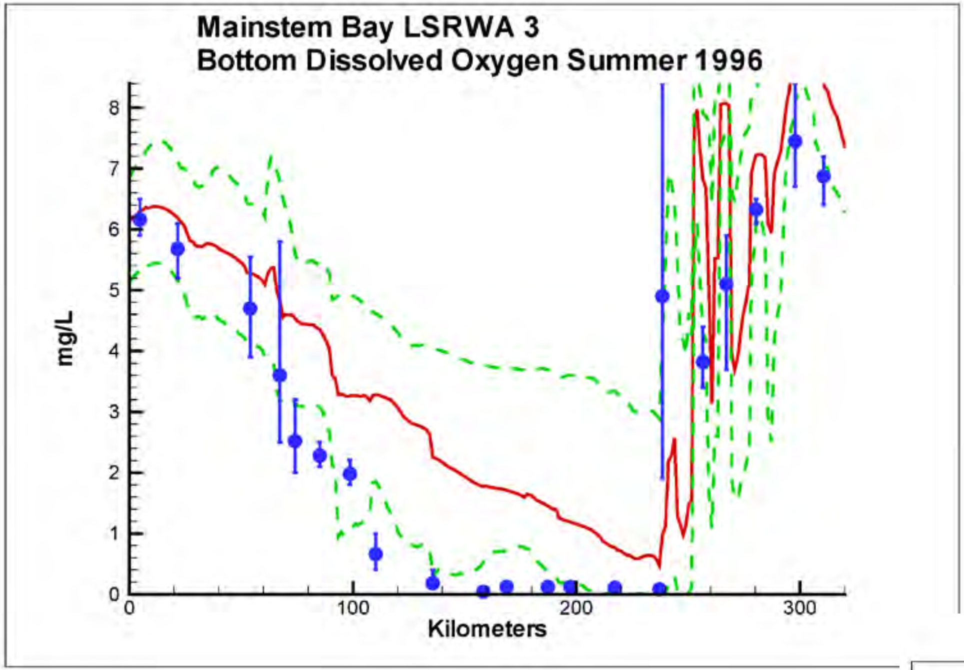




Base TMDL simulation shown in red.

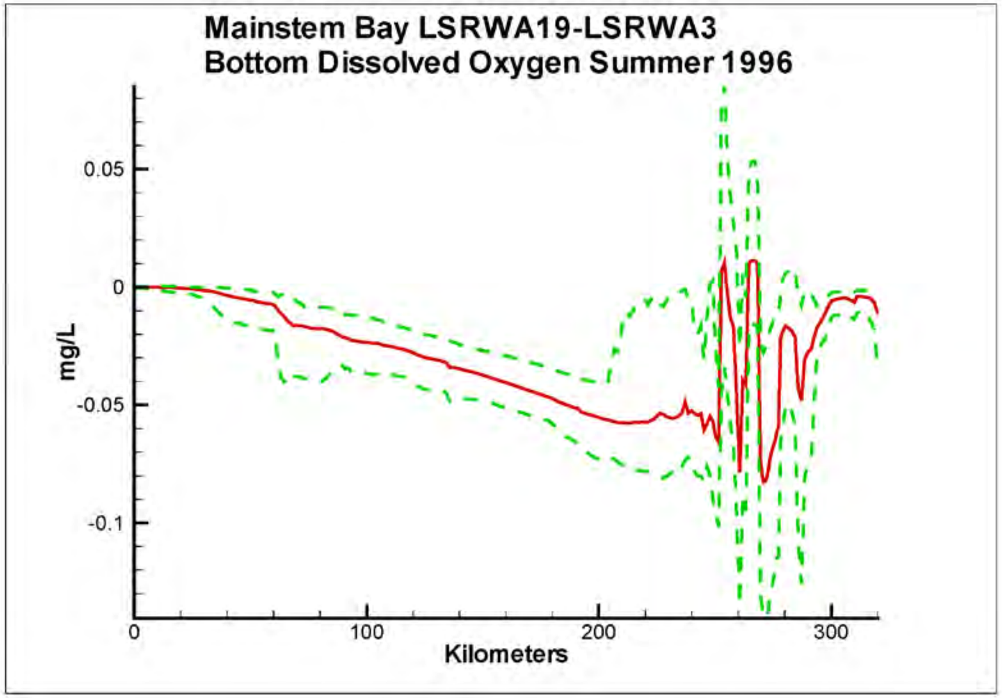
Difference plot showing effect of storm scour.

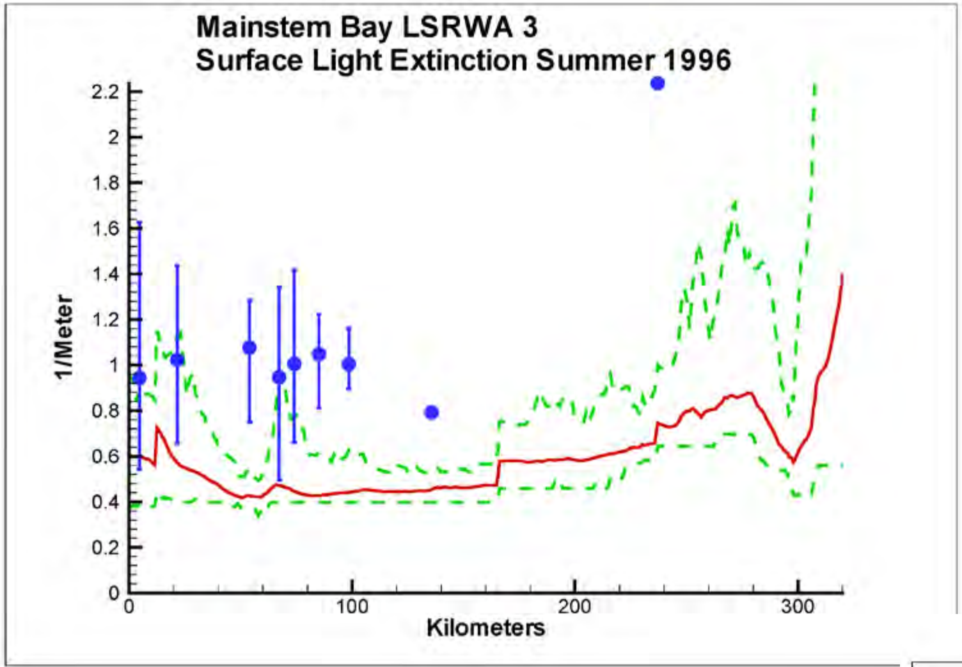




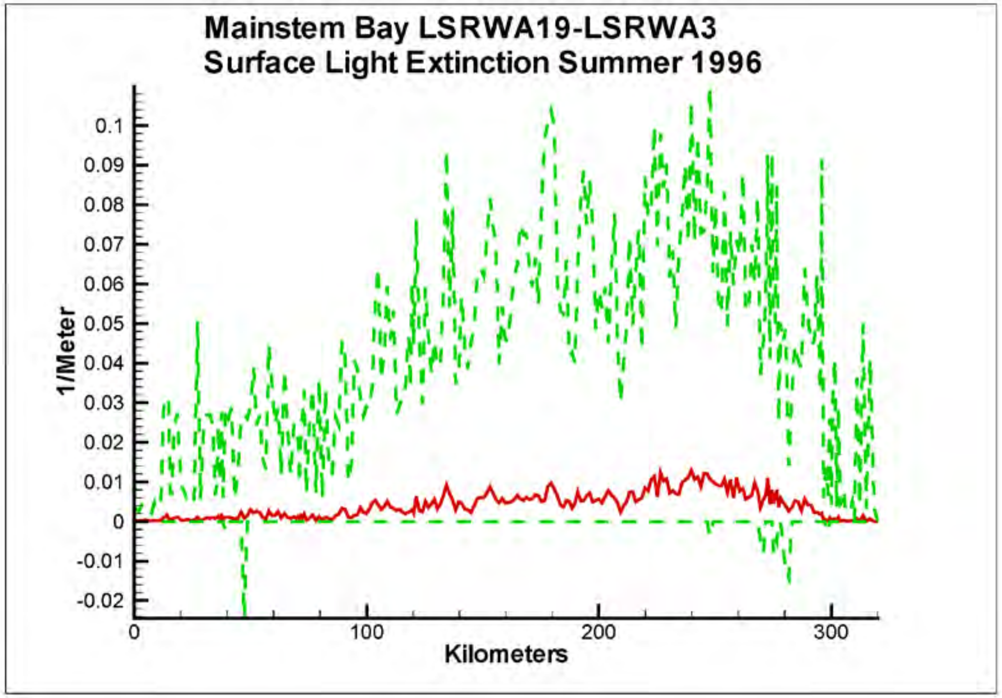
Base TMDL simulation shown in red.

Difference plot showing effect of storm scour.





Base TMDL simulation shown in red.



Difference plot showing effect of storm scour.

Let’s Switch Gears

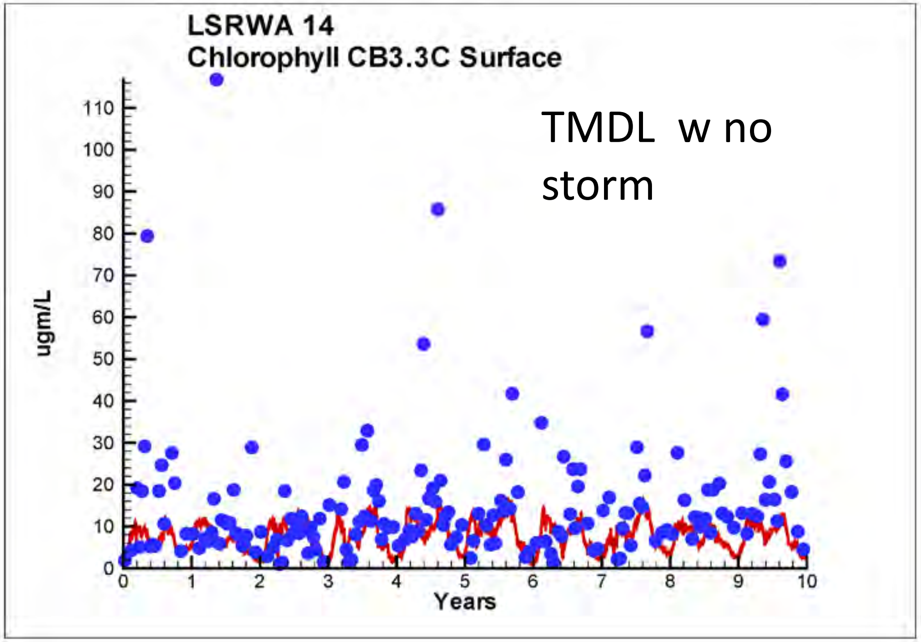
- We have been examining the effect of an erosion event. What about the timing of the event?
- Our colleagues at EPA CBP are active and interested. HSPF has been modified to produce storm scour consistent with USGS estimates.
- More important, EPA has produced hydrodynamics and WSM runs that move the 1996 storm to different months.

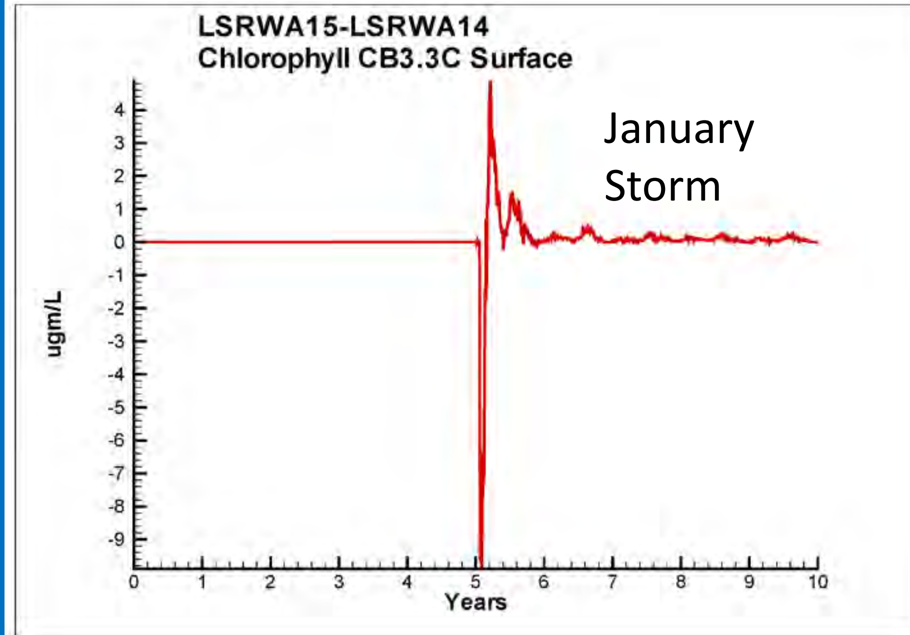
Timing of Storm Event

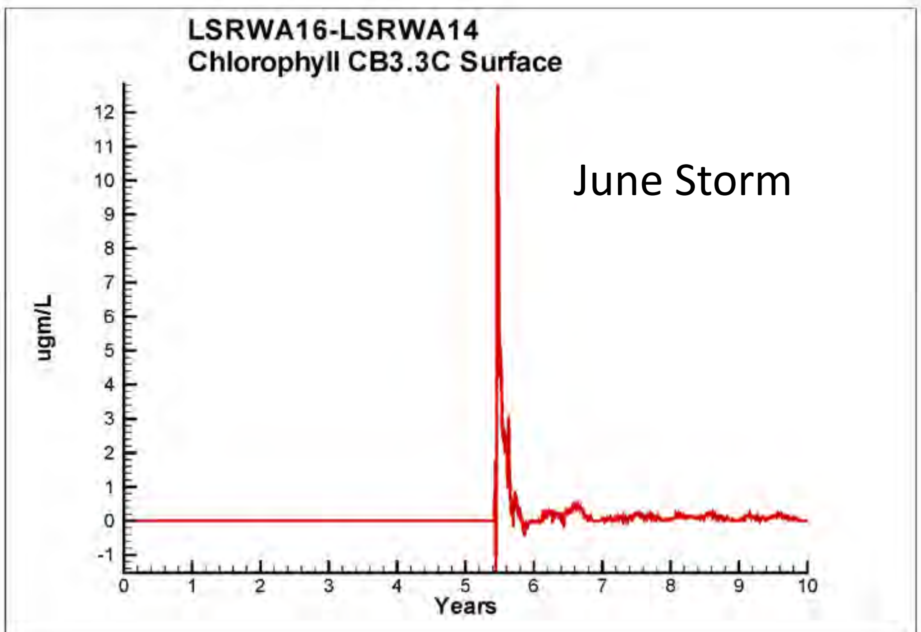
- The following runs have been completed in addition to a run with scour from the January 1996 storm:
  - No winter storm
  - Storm moved to June
  - Storm moved to October
- These runs examine the effect of the entire event including runoff and scour!

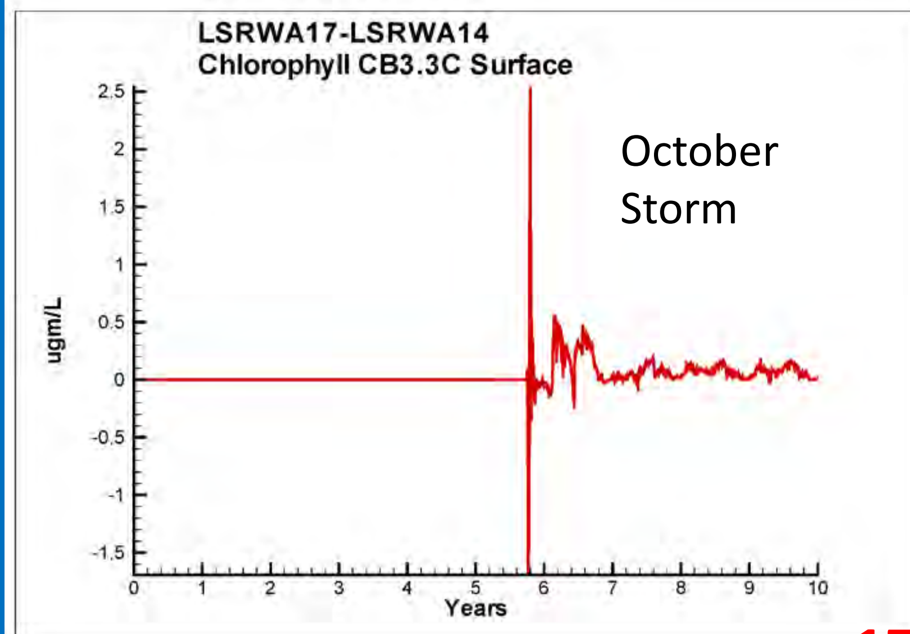
Scour Computed by Two Models

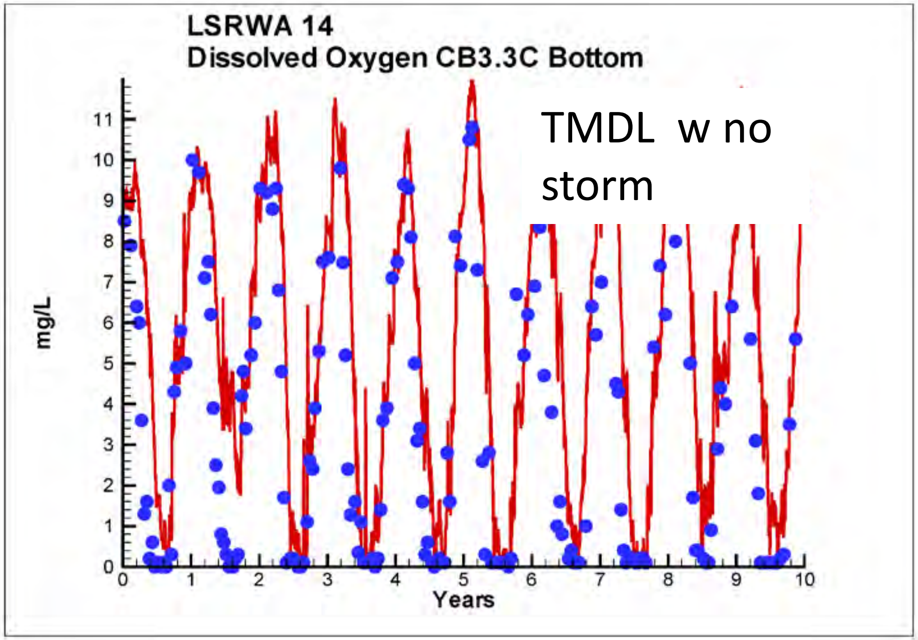
Scour	TSS (tons)	N (tons)	P (tons)
Jan 1996, ADH	2,107,311	6,322	2,107
Jan 1996, HSPF	1,837,861	588	2,141

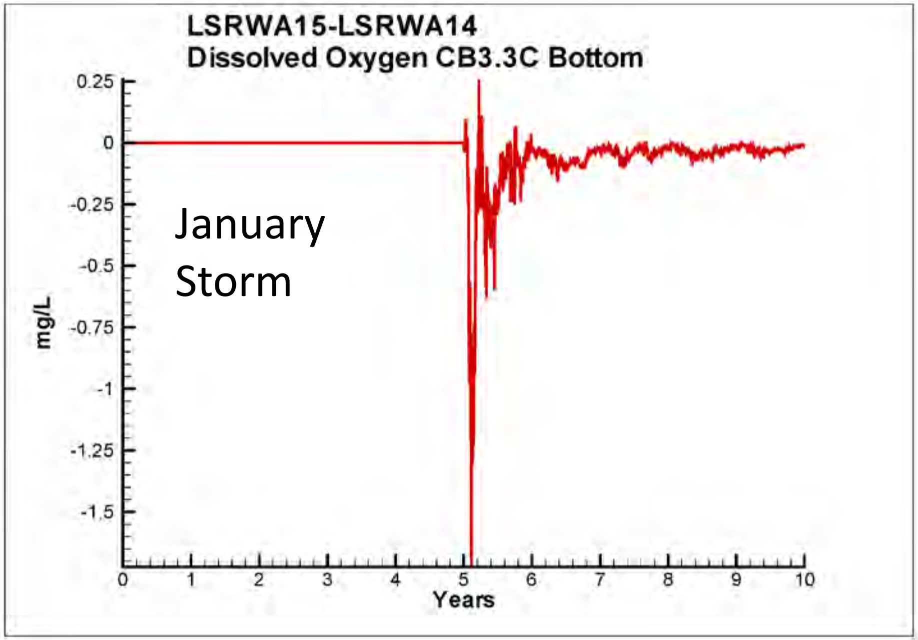

LSRWA 14
Chlorophyll CB3.3C Surface
TMDL w no storm
ugm/L
Years

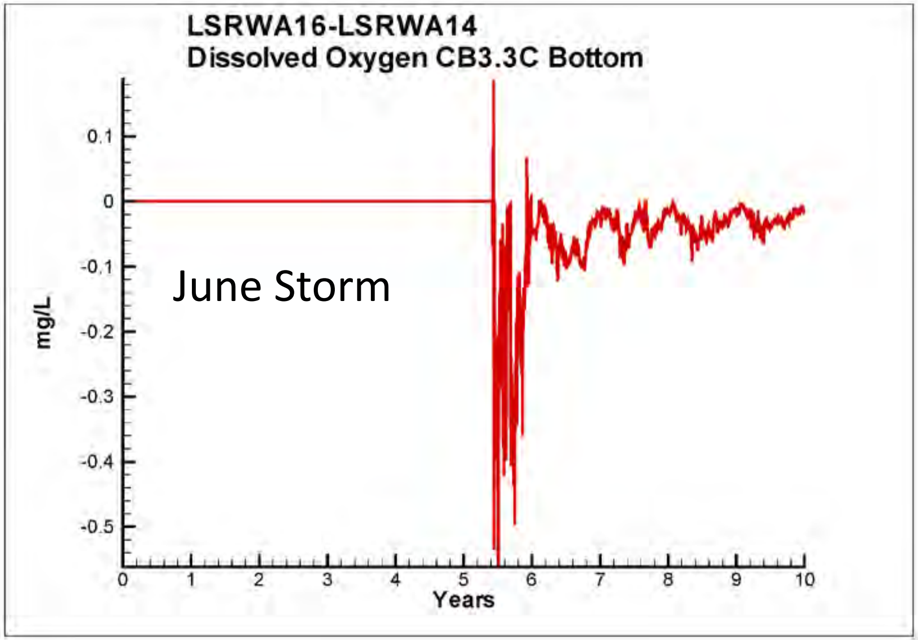

LSRWA15-LSRWA14
Chlorophyll CB3.3C Surface
January Storm
ugm/L
Years

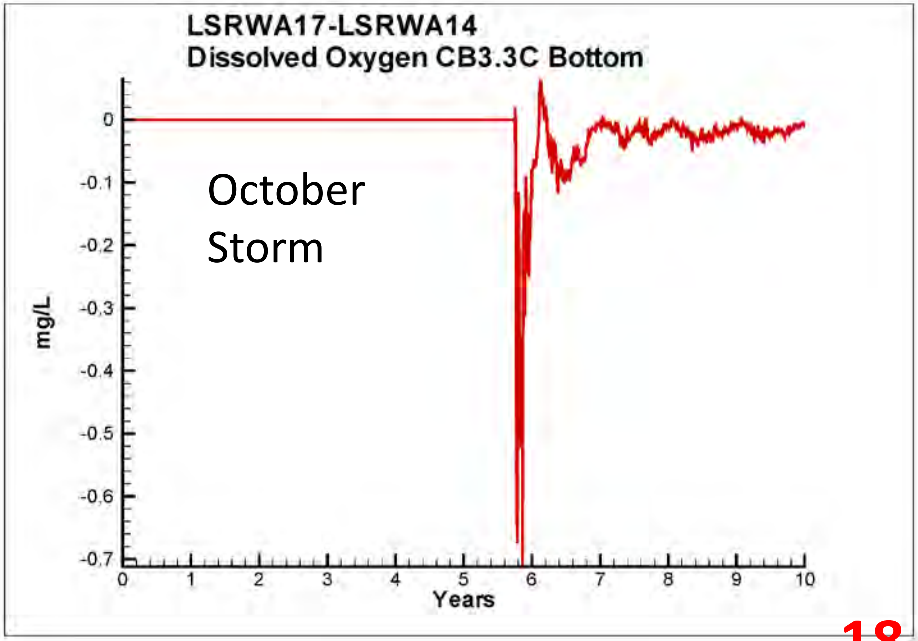

LSRWA16-LSRWA14
Chlorophyll CB3.3C Surface
June Storm
ugm/L
Years

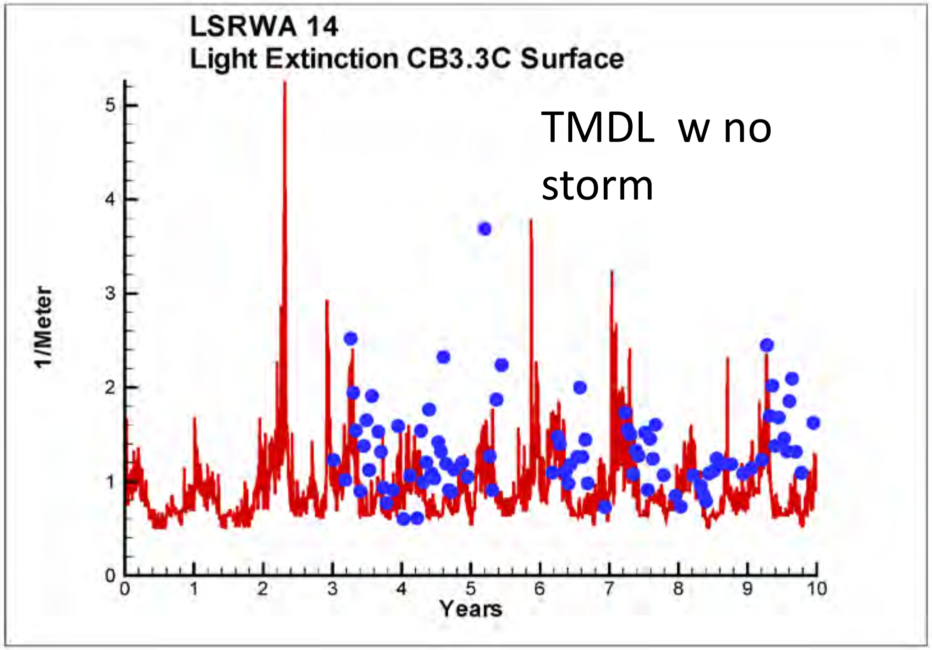

LSRWA17-LSRWA14
Chlorophyll CB3.3C Surface
October Storm
ugm/L
Years

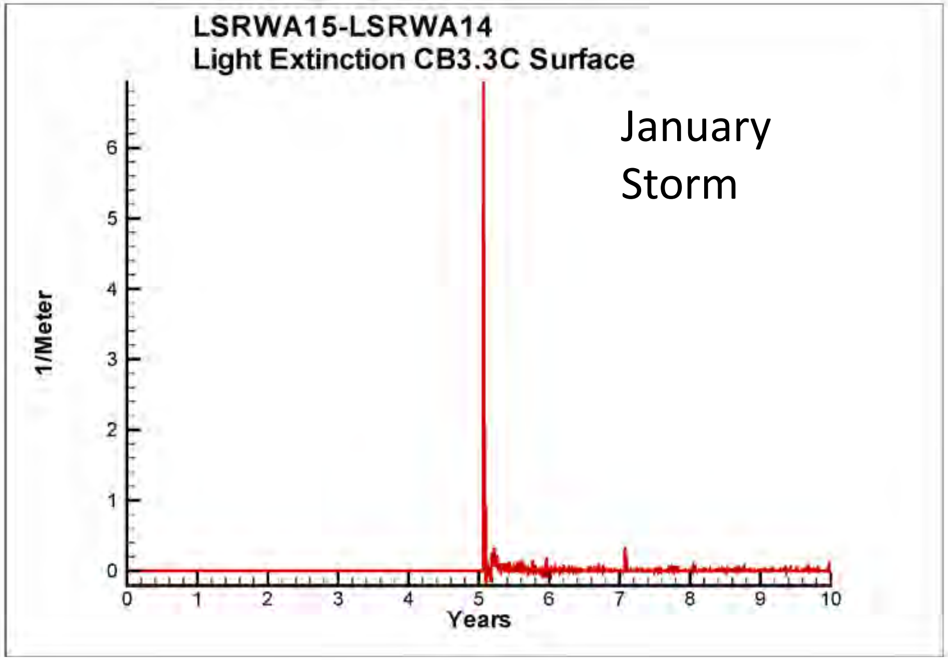

LSRWA 14
Dissolved Oxygen CB3.3C Bottom
TMDL w no storm
mg/L
Years

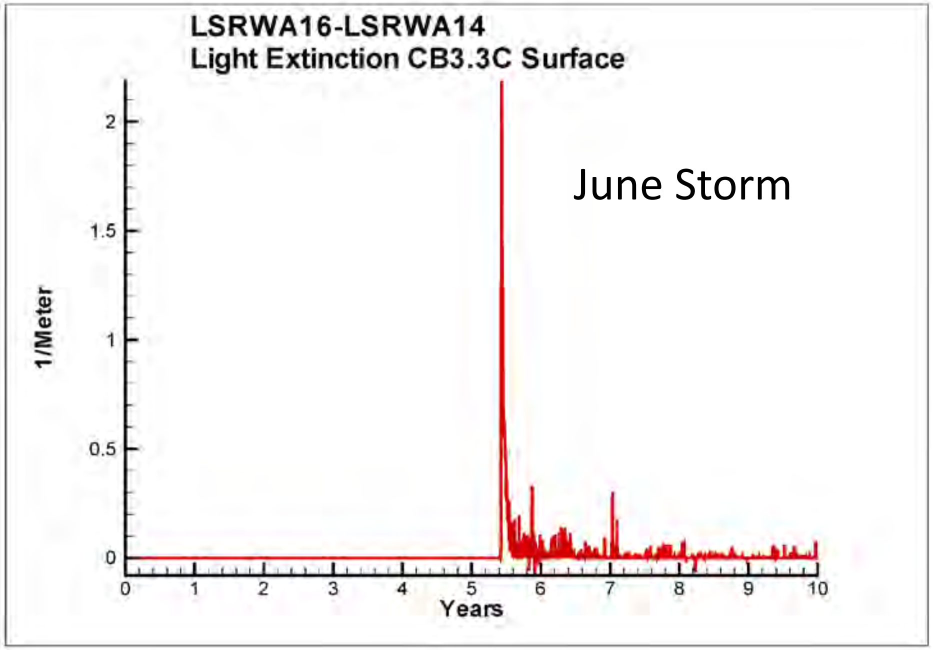

LSRWA15-LSRWA14
Dissolved Oxygen CB3.3C Bottom
January Storm
mg/L
Years

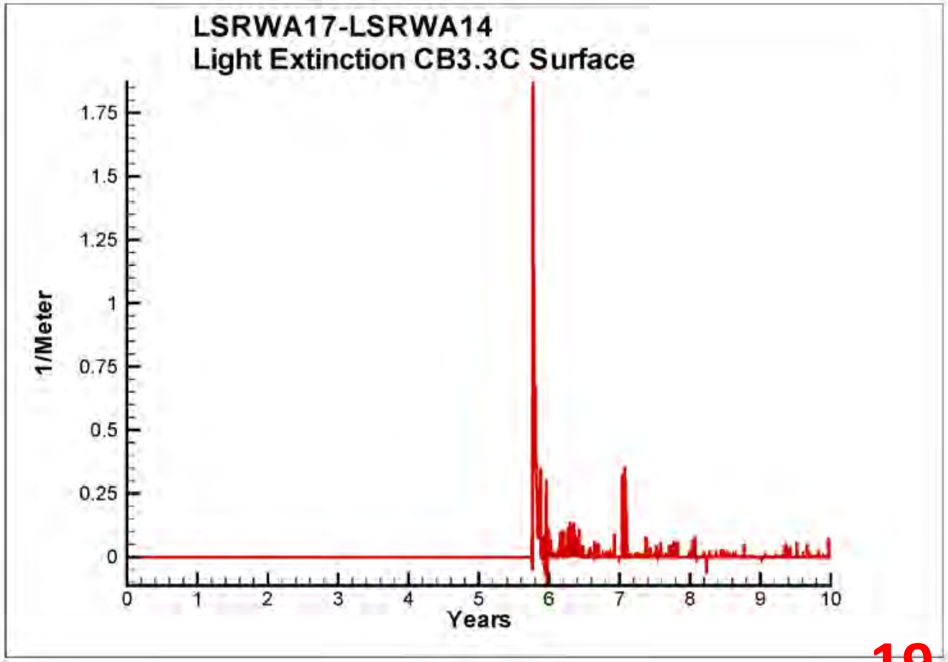

LSRWA16-LSRWA14
Dissolved Oxygen CB3.3C Bottom
June Storm
mg/L
Years

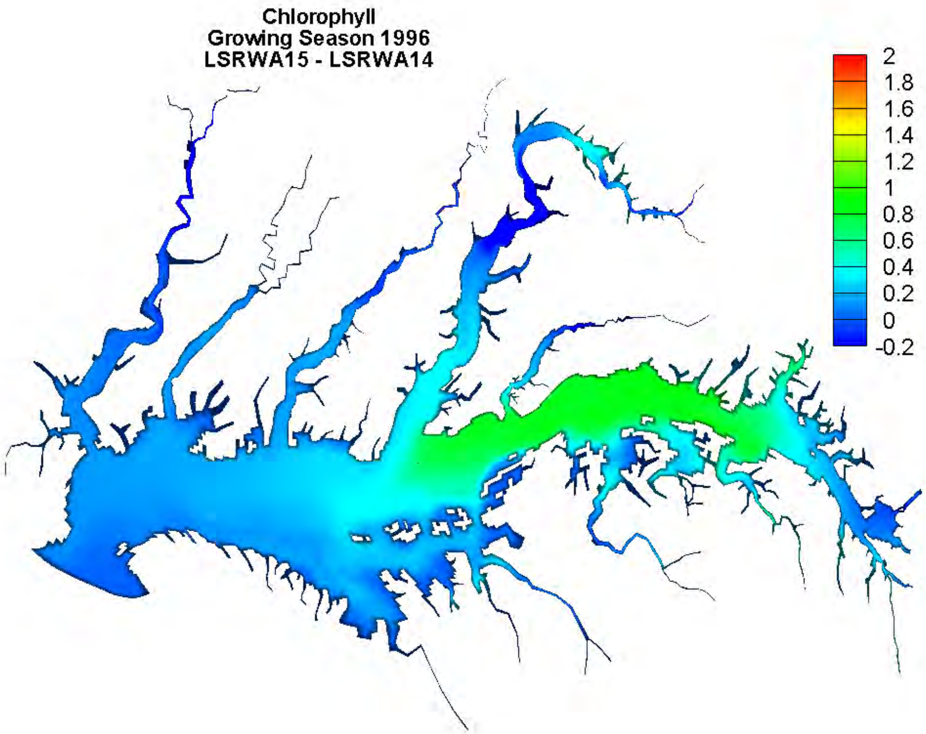

LSRWA17-LSRWA14
Dissolved Oxygen CB3.3C Bottom
October Storm
mg/L
Years


LSRWA 14
Light Extinction CB3.3C Surface
TMDL w no storm
1/Meter
Years

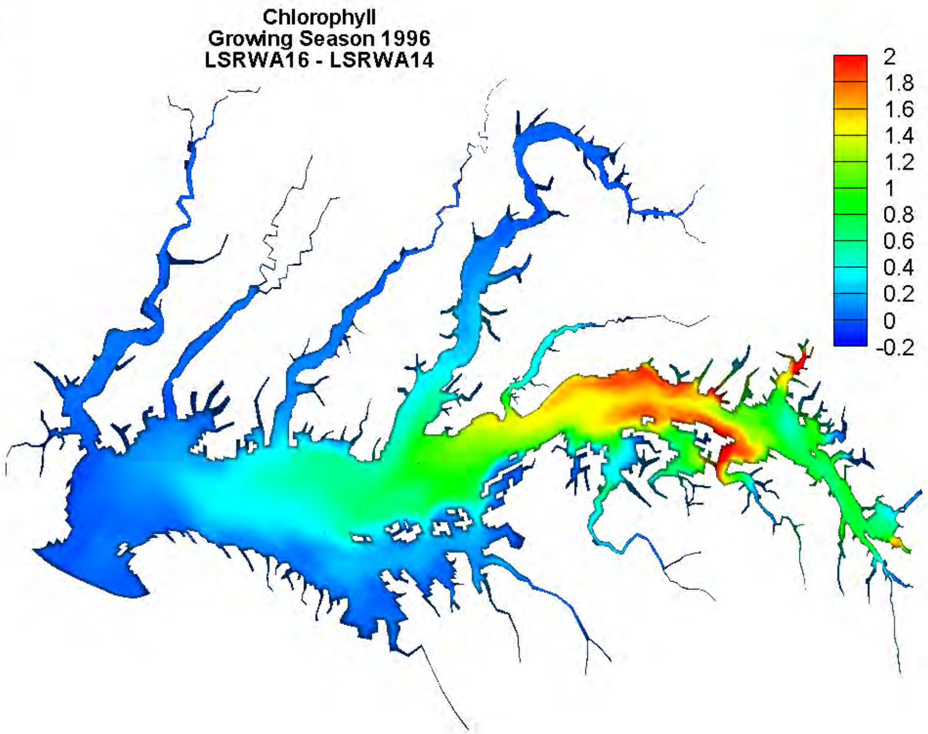

LSRWA15-LSRWA14
Light Extinction CB3.3C Surface
January Storm
1/Meter
Years


LSRWA16-LSRWA14
Light Extinction CB3.3C Surface
June Storm
1/Meter
Years

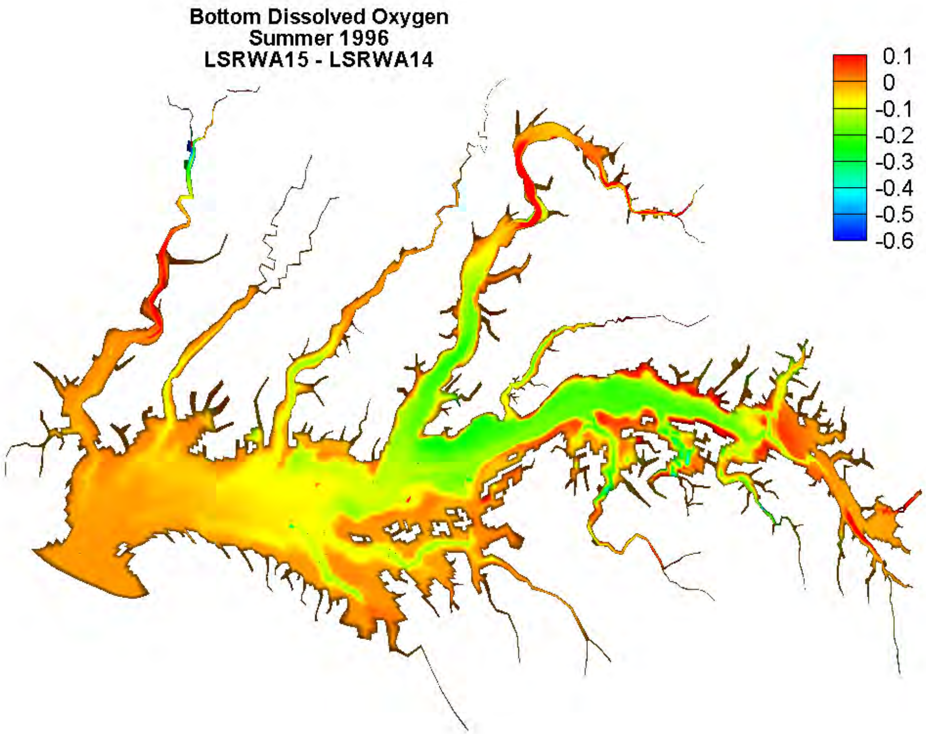

LSRWA17-LSRWA14
Light Extinction CB3.3C Surface
1/Meter
Years



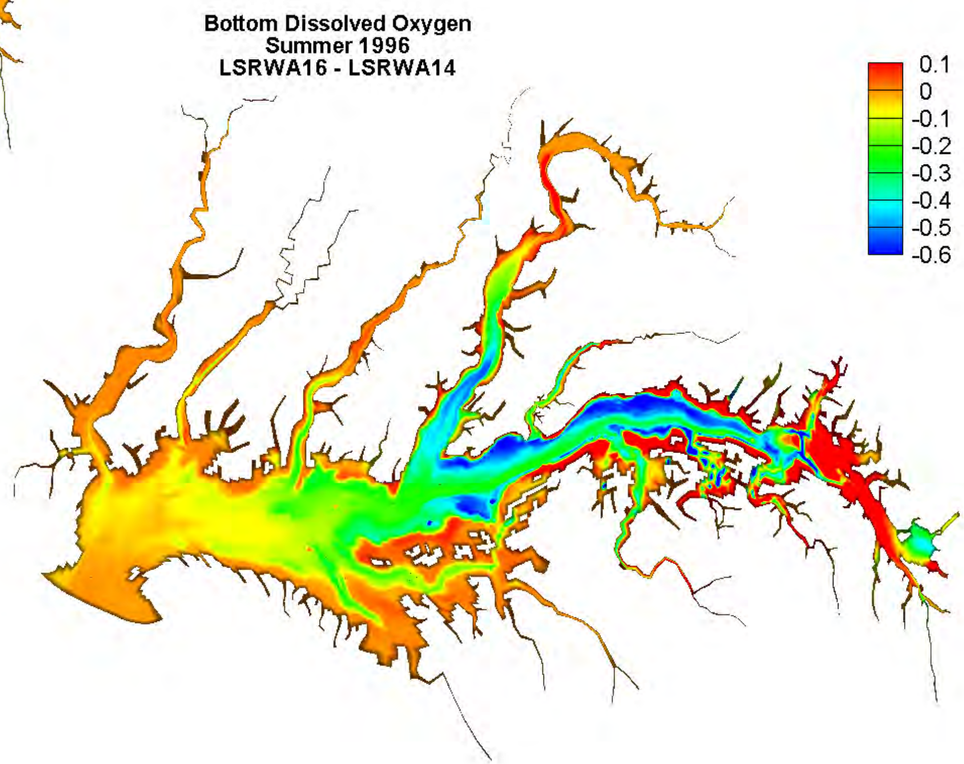
Marginal Effect of January Storm



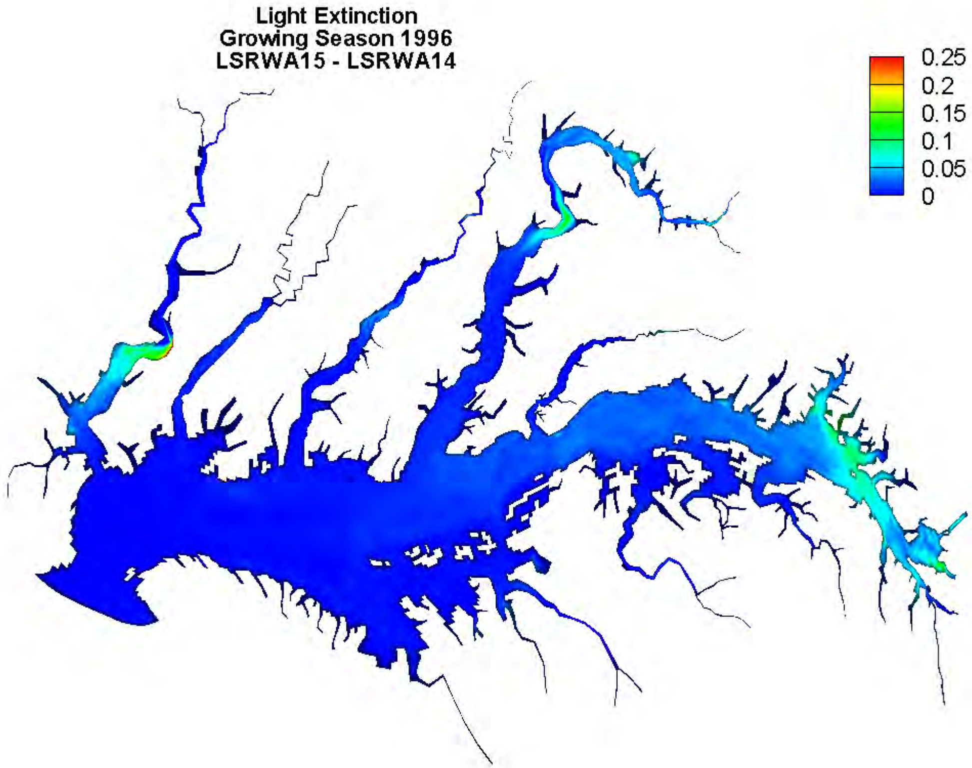
Marginal Effect of June Storm



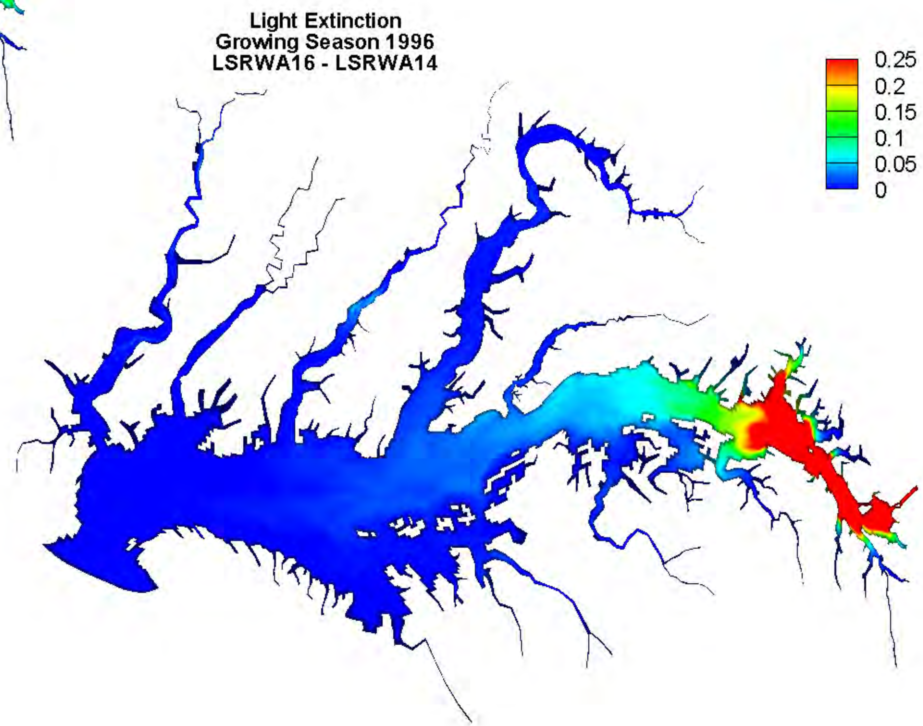
Marginal Effect of January Storm



Marginal Effect of June Storm



Marginal Effect of
January Storm



Marginal Effect of
June Storm

Lower Susquehanna River Watershed Assessment
Existing and Future Predicted Conditions

Condition Description	Parameters	Water Quality (WQ) Effects: Dissolved Oxygen (DO), Chlorophyll concentration (CHL), light attenuation (KE)	Sediment and Nutrient loads
1. What is the system's current condition?	1. Land use: 2010 land use. 2. Hydrology: 1991-2000. 3. Reservoir bathymetry: 1991-2000 Conowingo, Holtwood, Safe Harbor – Capacity (Conowingo is still trapping). 4. Scouring: No net scouring of reservoirs accounted for during this period.	1. Conditions are usually worst during wet periods of high loading and stratification. Results emphasize summer average (June-August) during wet year (1996). **2. Bottom-water hypoxia** (DO < 1 mg/L) for a 60-km reach extending 80 to 140 km below the Conowingo dam. Bottom waters in this reach exhibit **complete anoxia** on occasion. 3. Greatest average **CHL concentrations** (more **than 10 µg/L**) occur in surface waters of 60-km reach **extending 80 to 140 km** below the Conowingo dam. 4. Greatest computed **KE**, **~ 1.9/m**, occurs immediately downstream of the Conowingo outfall and declines rapidly with distance away from the dam. A secondary peak, **1.2/m, occurs downstream,** in the turbidity maximum located 40 km below Conowingo Dam. Guidelines indicate KE should not exceed 1.5/m for survival of SAV at the one-meter depth.	1. Solids- Average solids load over the 10-yr period is 3,056 metric ton/d. Maximum daily load is 181,910 metric ton/d. 2. Nitrogen- The average nitrogen load is 62.9 metric ton/d. Maximum daily load is 1,388 metric ton/d. 3. Phosphorus- Average load is 5.2 metric tons/d. Maximum daily load is 116 metric ton/d.
2. What is the system's condition if the WIPs are in full effect and reservoirs are still trapping?	1. Land use: WIPS in place. 2. Hydrology: 1991- 2000. 3. Reservoir bathymetry: 1991-2000 Conowingo, Holtwood, Safe Harbor – Capacity (Conowingo is still	1. Predicted **WQ improvements** with WIPS in place. Hypoxia reduced, less anoxic conditions, DO levels increase, chlorophyll concentrations and light attenuation decrease. **2. Bottom-water hypoxia** (DO < 1 mg/L) in a 20-km reach (was 60-km reach when WIPS are not in effect) extending 80 to 100 km below Conowingo.	1. Solids- Average solids load over the 10-yr period) is 2,307 metric ton/d. Maximum daily load is 134,960 metric ton/d. 2. Nitrogen- Average nitrogen load is 46.1 metric ton/d. Maximum daily load is 1,010 metric ton/d.

Condition Description	Parameters	Water Quality (WQ) Effects: Dissolved Oxygen (DO), Chlorophyll concentration (CHL), light attenuation (KE)	Sediment and Nutrient loads
	trapping). 4. Scouring: No net scouring of reservoirs accounted for during this period.	3. Minimum summer-average DO is ~ 0.5 mg/L. Occasional excursions to zero (anoxia) mg/L still predicted. **4. Surface CHL** concentration in this reach **declines** by 3 µg/L, relative to the current condition, to ~ 7 µg/L. **5. KE** just below Conowingo **declines** by 0.5/m, relative to the current condition (scenario 1), to 1.4/m and by 0.4/m to 0.8/m within turbidity maximum (TM, moves according to flow, during most summers TM is located 20 to 40 km upstream of the head of the trench.).	3. Phosphorus- 3.9 metric tons/d. Maximum daily load is 86.8 metric ton/d.
3. What is the system's condition when WIPS are in full effect, reservoirs are still trapping sediments and a scour event occurs during winter?	1. Land use: WIPS in place. 2. Hydrology: 1991-2000 with 1996 winter scour event. 3. Reservoir bathymetry: Conowingo, Holtwood, Safe Harbor –2011 Capacity, Conowingo still trapping. 4. Scouring: Jan 96 scour event	1. DO would be depressed in comparison to WIPS in place with no scouring event (#2). 2. Storm timing important. Winter scour has minimal impacts to WQ by summer. 3. The additional loads from the scour event **depress** summer-average, bottom-water, **DO** by 0.05 mg/L for roughly 60 km along the bay axis (along the centerline following the channel) in the summer following the storm. (in comparison to #2 **WIPs in full effect**) 4. DO values vary-The effect is diminished in shallow areas relative to deeper areas. There are freshwater flow pulses and meteorological events which cause the effect on DO to vary over the course of a season. **5. CHL** (**summer average) increases** by 0.3 µg/L in the worst areas (in comparison to #2 **WIPs in full effect**). The effect on CHL is spatially extensive. An increase of 0.2 µg/L or more extends 150 km along the bay axis in the summer following the storm.	1. Solids- Scour event adds 2,400,000 metric tons solids over a four day period. 2. Nitrogen- Adds 7,100 metric tons nitrogen over a four day period. 3. Phosphorus- 2,400 metric tons over a four day period.

Condition Description	Parameters	Water Quality (WQ) Effects: Dissolved Oxygen (DO), Chlorophyll concentration (CHL), light attenuation (KE)	Sediment and Nutrient loads
		6. Summer-average **KE increases by 0.01/m (in comparison to #2-WIPs in full effect).** Additional solids load disperse and settle before SAV growing season (April-October). KE increase attributed to the organic matter, phytoplankton and detritus, stimulated by the scoured nutrient load. 7. Although solids may be subject to resuspension, the January scour effect on **summer KE is negligible.** 8. Nutrients associated with the storm event are persistent into summer, while solids are short-lived. They settle out but they are recycled though the chemical and physical processes that the bottom sediments undergo. The effect of the scoured nutrients diminishes with time but is **visible five summers** subsequent to the scour event.	
4. What is the system's condition when WIPS are not in effect, reservoirs are full and there is a winter scour event?	1. Land use: 2010 land use 2. Hydrology: 1991-2000 with 1996 winter scour event 3. Reservoir bathymetry: Conowingo, Holtwood, Safe Harbor – Capacity at full. 4. Scouring: Jan 96 scour event.	1. Scour under reservoir-full conditions was similar to scour with current conditions (2011 bathymetry). This shows that by 2011, the reservoirs were essentially full. 2. When flow is below scour threshold **full-reservoir conditions are similar to non-full conditions**. Solids settle even when reservoir is "full" and settlement rate is not dependent on bathymetry. When flow is below the scour threshold, loads from the reservoir are the same between current bathymetry (2011) and reservoir full. Consequently, water quality in the bay is the same, as long as there is no scour event. 3. A **full reservoir is influential** when **scour** takes place; more material is scoured under reservoir-full conditions. 4. Summer-average **DO is depressed by 0.04 mg/L** (in comparison to scenario #1) along a 100 km reach of bay bottom. Examination of the marginal effects on DO can be deceptive: in the region of the worst hypoxia, at the worst location, under existing conditions, average DO is almost zero. It can't go much lower. Therefore DO isn't depressed	1. Solids -Adds 2,400,000 metric tons solids, over a four day period. 2. Nitrogen - 7,100 metric tons nitrogen, over a four day period. 3. Phosphorus - 2,400 metric tons phosphorus, over a four day period. The amount scoured is virtually equal to the amount scoured under existing bathymetry, indicating the existing bathymetry is very close to full.

Condition Description	Parameters	Water Quality (WQ) Effects: Dissolved Oxygen (DO), Chlorophyll concentration (CHL), light attenuation (KE)	Sediment and Nutrient loads
		much because there is nowhere to go. Elsewhere, DO might average 0.5 mg/L so it can go down by 0.5. The greatest magnitude of depression is not where DO is worst, on average. 5. **CHL (summer average) increases by 0.2 µg/L for a 100 km** reach of the bay axis. **6. Impact of the winter scour event on summer KE is minima**l (less than 0.02/m increase). This increase due to phytoplankton and organic matter associated with scoured nutrients rather than scoured sediments.	
5. What is the system's condition when WIPs are in full effect, the reservoirs are full and there is a winter scour event?	1. Land use: WIPs in place 2. Hydrology: 1991-2000 with 1996 winter scour event. 3. Reservoir bathymetry: Conowingo, Holtwood, Safe Harbor – Capacity at full. 4. Scouring: Jan 96 scour event.	1. When flow is below scour threshold **WQ conditions are similar** whether reservoir is full or not. 2. If a scour event occurs, average bottom DO concentration is depressed **by 0.05 mg/L for 60 to 80 km along the bay axis.** With WIPS in place, summer-average DO is higher than under 2010 conditions. Since summer-average DO is higher, it can go lower before hitting zero. So the magnitude of depression can be worse for the WIPS than for 2010. 3. **CHL increases by 0.3 µg/L in the 20 km reach** where CHL is maximum. **CHL increases by 0.2 µg/L for 120 km** or more along the bay axis. 4. It is possible for CHL to increase (worsen) with WIPS in place due to the fact that with WIPS in place the nutrient limitation of algae is more stringent; therefore the added nutrients from the scour event can stimulate a bit more chlorophyll. 5. **KE increase is ~ 0.01/m or less** since additional solids disperse and settle before summer. The minimal KE effects are	1. Solids- Adds 2,400,000 metric tons, over a four day period. 2. Nitrogen – Adds 7,100 metric tons nitrogen, over a four day period. 3. Phosphorus – Adds 2,400 metric tons, over a four day period. The amount scoured is not affected by WIPS.

Condition Description	Parameters	Water Quality (WQ) Effects: Dissolved Oxygen (DO), Chlorophyll concentration (CHL), light attenuation (KE)	Sediment and Nutrient loads
		almost identical to predictions with reservoirs still trapping (i.e. 2011 bathymetry/KE impacts are about the same if there is winter storm whether the reservoir is "full" or as it is now (still trapping) which is expected since the solids scoured have ample time to settle before the critical SAV growth period.	
6. What is the system's condition if WIPs are in full effect, reservoirs are full and a large scour event occurs during (a) summer or (b) fall or (c) winter?	1. Land use: WIPs in place 2. Hydrology: 1991 - 2000. Runoff from January 1996 flood event is moved to June or October. 3. Reservoir bathymetry: Conowingo, Holtwood, Safe Harbor – Capacity at full. 4. Scouring: Jan 96 scour event occurring in January, June and October.	1. June storm has the most deleterious effect on summer water quality. The October storm has the least deleterious effect, followed by the January storm. 2. The DO response to a storm is two-phased. As storm water passes there is an **initial sharp decrease reflecting the DO concentration** in the storm water and, perhaps, the effects of vertical density stratification. Following storm passage, a **secondary DO depression results** from oxidation of organic matter produced by storm-generated nutrient loads. 3. June storm, the two phases are difficult to separate. Summer-average bottom-water DO depression at the head of the trench (fixed bathymetric feature in Bay) is **0.4 mg/L** or more in comparison to Scenario 2. 4. January storm- **DO depression** (same location as June storm) **is 0.2 mg/L and October storm** depression is **0.1 mg/L** 5. Spatial extent of the storm influence is large and DO depression is readily detected in the lower portion of the Potomac River which joins Chesapeake Bay roughly 200 km below Conowingo Dam. 6. CHL response to a storm is two-phased. **CHL concentration declines immediately** as the storm water passes then **CHL increases**, stimulated by the nutrients introduced by the storm.	1. Solids – Adds 2,226,000 metric tons 2. Nitrogen- Adds 3,642 metric tons organic nitrogen 3. Phosphorus- Adds 2,169 metric tons particulate phosphorus.

Condition Description	Parameters	Water Quality (WQ) Effects: Dissolved Oxygen (DO), Chlorophyll concentration (CHL), light attenuation (KE)	Sediment and Nutrient loads
		7. January storm, spring bloom, **CHL increases as much as 5 µg/L**, although the bloom largely precedes the critical SAV growing season. In the summer subsequent to the storm, the **increase in CHL concentration is between 0.5 and 1 µg/L** over a large reach of the bay, extending to the mouth of the Potomac River. 8. October storm – **CHL increases by 0.5 µg/L.** 9. June storm introduces nutrients at the beginning of the seasonal peak in primary production, summer-average **CHL concentration increases** as much as **3 µg/L** 10. Solids loads from the June storm remain in suspension during the subsequent summer months resulting in **KE increase of 2/m to 4/m** (in comparison to scenario 2) for a reach extending 60 km downstream of the dam . Solids loads from the January and October storms are dispersed and settle long before the subsequent SAV growing season and have negligible effect on KE during this period.	

Chesapeake Bay Environmental Model Package (CBEMP). The CBEMP consists of the Corps' CH3D hydrodynamic model, the Corps' ICM water quality model and the Chesapeake Bay Program's Watershed Model (WSM)

Rankings:

What is the BEST future condition?

1) WIPS in place, reservoirs still trapping, no scouring. (Condition #2).

2) WIPS in place, reservoirs still trapping, scouring. (Condition #3).

3) WIPS in place, reservoirs full, scouring (Condition #5)

What is the worst-case future condition?

1) No management action in the watershed, no management action to mitigate major scour events. (Condition #4).

What is the worst time of year to have a scour event?

Ranked from most detrimental to least detrimental:

1) Late spring, early summer (e.g. June)

2) Winter (e.g. January)

3) Fall (e.g. October)

In summary

The management action that shows the greatest benefit (improvement to WQ) to the Bay is the WIP fully implemented, no major scour event, dam still filling (#2). If no management actions are taken the reservoir will "fill." The Worst Case is No WIPS, no action to mitigate major scour events (full reservoir) and a scour event. Under normal hydrologic conditions, even if Conowingo is "full" it will still be trapping, i.e. there will not be a continuous flow of sediment and nutrients into Chesapeake Bay. However we will see more frequent scouring events because the threshold for erosion will be lower. Also there is potential for a greater magnitude of impacts to WQ because there will be more sediments and nutrients associated with these more frequent scour events.

Lower Susquehanna Placement Options									
Name	**Acreage**	**Lifespan (years)**	**Capacity in Cubic Yards (cy) Yearly/Lifespan Volumes**	**Access**	**Tipping Fee ($)**	**Limitations**	**Distance from Conowingo (mi)**	**Option Pro's**	**Option Con's**
Beneficial Use									
Harbor Rock	N/A	Indefinite	**Lifespan Capacity** -- **Yearly Capacity** 500,000 cy/year	Road, barge	0	Limited annual amount; dry only	Variable	Indefinite lifespan; beneficial use	Material must be dried ($); have to build plant. They will be paid 2 times -- once for material and once to sell the material.
Island Creation	Variable	Indefinite	**Lifespan Capacity** Variable, until island is filled. **Yearly Capacity** Volume depends on island size and volume dredged per year.	Pipeline, barge	0	Environmental regulations; erosion; sandy material only	Max. 75	Material can be wet; no tipping fee; beneficial use; more flexibility in amount of material that can go to this site .	Possible erosion; environmental hurdles; state law forbids island creation in the upper Bay; material must be sandy; barges with associated load and unload fees; confinement is necessary.
Smith Island Restoration	Variable	Indefinite	**Lifespan Capacity** Variable, until island is filled. **Yearly Capacity** Volume depends on island size and volume dredged per year.	Barge	0	Environmental regulations; erosion; sandy material only	128	Material can be wet; no tipping fee; beneficial use; more flexibility in amount of material that can go to this site .	Possible erosion; environmental hurdles; material must be pure sand; barges will be involved and there will be the associated load and unload fees; confinement is necessary; longer transport distance than for man-made islands near the dams.

Name	Acreage	Lifespan (years)	Capacity in Cubic Yards (cy) Yearly/Lifespan Volumes	Access	Tipping Fee ($)	Limitations	Distance from Conowingo (mi)	Option Pro's	Option Con's
Fringe Wetland Creation	Variable	Indefinite	**Lifespan Capacity** Variable, until wetland is filled. **Yearly Capacity** Small volume depends on the wetland size.	Road, pipeline, barge	0	Smaller quantities; erosion; environmental regulations; confinement necessary	Max. 75	Material can be piped; material can be wet; no tipping fee; beneficial use; more flexibility in amount of material that can go to this site.	Possible erosion; environmental hurdles; ***material must be sandy?;*** barges will be involved and there will be the associated load and unload fees; confinement is necessary; smaller amounts of material can be placed vs. island creation.
Manufactured Soil	Variable	Indefinite	**Lifespan Capacity** -- **Yearly Capacity** Variable	Road, pipeline, barge	0	Dry only	Variable	No tipping fee; volume depends on demand for material; beneficial use.	Material must be dried ($); must have other material to mix dredge material with, such as compost; need confinement.
Dyke Marsh (Potomac, MD)	245	Indefinite	**Lifespan Capacity** -- **Yearly Capacity** 2,000 cy/day; ~700,000 cy/year; dependent on whether they have a placement cell available at needed time.	Pipeline, barge	0	Environmental regulations; erosion; confinement necessary	230	Most likely no tipping fee	Barges will be involved and associated load and unload fees; environmental hurdles; longer transport distance than for man-made islands near the dams; whether a placement cell will be ready when we need to dredge is a question.

Name	Acreage	Lifespan (years)	Capacity in Cubic Yards (cy) Yearly/Lifespan Volumes	Access	Tipping Fee ($)	Limitations	Distance from Conowingo (mi)	Option Pro's	Option Con's
Open Water									
Altering Reservoir Operations and Release Downstream	N/A	N/A	**Lifespan Capacity** Variable **Yearly Capacity** Variable	N/A	0	Environmental regulations/ impacts; needs of dam operators to make electricity	0	Low to no operational costs; allows for decisions to be made when to release downstream	Environmental impacts; legal issues
Pump Downstream	N/A	N/A	**Lifespan Capacity** Variable **Yearly Capacity** Variable	N/A	0	Environmental regulations/ impacts	N/A	Lower costs	Environmental impacts; legal issues
Pooles Island - Open Water	1,700	Indefinite	**Lifespan Capacity** Unknown **Yearly Capacity** 5,000,000 cy/year	Barge	0		32	Material can be wet; no tipping fee.	Currently cannot place material here legally; if could, material would need to be barged, therefore load and unload fees; environmental hurdles
Ocean Placement	N/A	Indefinite	**Lifespan Capacity** Unlimited **Yearly Capacity** Depends on volume dredged per year	Barge	0	Must pass bioassays	240	Material can be wet; no tipping fee; most likely larger volumes could be acceptable.	Very large distance; environmental hurdles; barges will be involved and there will be the associated load and unload fees.
Wolf Trap and Rappahannock, VA	N/A	Indefinite	**Lifespan Capacity** -- **Yearly Capacity** 500,000 cy/year to 1,000,000+ cy/year	Barge	0	Needs VA approval	155	Larger volumes could be accepted.	Need Virginia approval; large distance; environmental hurdles; barges with associated load and unload fees; maybe not enough barges to do job; material must be dewatered($); currently used by MPA.

Name	Acreage	Lifespan (years)	Capacity in Cubic Yards (cy) Yearly/Lifespan Volumes	Access	Tipping Fee ($)	Limitations	Distance from Conowingo (mi)	Option Pro's	Option Con's
Upland Placement									
Purchase Land -- Staging Area / Placement Site	Variable (100+)	Indefinite	**Lifespan Capacity** Variable, until land is filled. **Yearly Capacity** Volume depends on land size and volume dredged per year	Road, pipeline, barge	N/A	Cost; contamination; zoning	Variable	Potentially large capacity; could help as a place to dry material for other sites.	Cost; must meet state regulations (PADEP for PA and MDE for MD); transport containers must be watertight; distance; purchase of land will be needed.
Shirley Plantation	1,800	Indefinite	**Lifespan Capacity** -- **Yearly Capacity** 500,000 cy/year 1,000,000 +40-60 million in mine reclamation	Road, barge	$50/cy	Must meet VA chemical criteria	270	Large capacity; potential to help with reclamation	Must meet regulations; transport containers must be watertight; distance
Abandoned Mines	Variable	Indefinite	**Lifespan Capacity** Variable, until mine is filled. **Yearly Capacity** Volume depends on mine size and volume dredged per year.	Road, pipeline, barge	Unknown	Environmental regulations	Variable	Large capacity; reclamation	Must meet regulations; transport containers must be watertight; distance
Landfills - Capping									
Modern Landfill (York, PA)	80	8	**Lifespan Capacity** 240,000 cy **Yearly Capacity** TBD	Road, rail	$30/ton	PADEP regulations; dry only	37**	Some capacity; distance	PADEP regulations; tipping fees; dry material $
Republic Materials (Conestoga, PA)	80	26	**Lifespan Capacity** 240,000 cy **Yearly Capacity** TBD	Road, rail	$30/ton	PADEP regulations; dry only	46	Some capacity; distance	PADEP regulations; tipping fees; dry material $
Scarboro Landfill (Aberdeen, MD)	106	Unknown	**Lifespan Capacity** 318,000 cy **Yearly Capacity** TBD	Road, pipeline	To be determined	Dry only	13*	Some capacity; distance	Environmental regulations; tipping fees; dry material $
Quarries									

Name	Acreage	Lifespan (years)	Capacity in Cubic Yards (cy) Yearly/Lifespan Volumes	Access	Tipping Fee ($)	Limitations	Distance from Conowingo (mi)	Option Pro's	Option Con's
Stancil Quarry (Perryville, MD) - (Potential to be Pumped Directly)	70	Unknown	**Lifespan Capacity** 9,000,000 cy **Yearly Capacity** TBD	Road, pipeline	$4/cy		13*	Large capacity	Must meet state regulations (PADEP for PA and MDE for MD); tipping fees; may only take dry material; drying ($); watertight transport; distance.
Port Deposit Quarry (MD) (Potential to be Pumped Directly)	68	Indefinite	**Lifespan Capacity** 3,250,000 cy **Yearly Capacity** TBD	Road, rail, pipeline	0		3.5*	Large capacity	Same as Above
Penn/MD Materials (Peach Bottom, PA) (Potential to be Pumped Directly)	60	25-30	**Lifespan Capacity** 9,000,000 cy **Yearly Capacity** TBD	Road, pipeline	To be determined	PADEP regulations	5*	Large capacity	Same as Above
Penn/MD Materials (Skippack, PA)	100	Unknown	**Lifespan Capacity** 300,000 cy **Yearly Capacity** TBD	Road	To be determined	PADEP regulations	72	Some capacity	Same as Above
Mason Dixon Materials (Belvidere Plant, Cecil County MD) (Potentially be Pumped Directly)	565	40	**Lifespan Capacity** 113,000,000 cy **Yearly Capacity** TBD	Road, pipeline	To be determined		12.5*	Large capacity	Same as Above
Mason Dixon Materials (Perryville Plant, Perryville MD) (Potentially be Pumped Directly)	107	40	**Lifespan Capacity** 21,400,000 cy **Yearly Capacity** TBD	Road, pipeline	To be determined		12.3*	Large capacity	Same as Above
Mason Dixon Materials (Cecil Plant, Cecil County MD) (Potential to be Pumped Directly)	150	40	**Lifespan Capacity** 16,050,000 cy **Yearly Capacity** TBD	Road, pipeline	To be determined		10*	Large capacity	Same as Above
Mason Dixon Materials (Westgate Plant, York PA)	21	Indefinite	**Lifespan Capacity** 3,060,000 cy **Yearly Capacity** TBD	Road, rail	To be determined	PADEP regulations	38	Large capacity; closer to dams	Same as Above
(11) Pennsy Supply Sites (Pennsylvania)	--	Unknown	Initially indicating that they do not have the ability to assist in the disposal of material	Road, rail	--	PADEP regulations; mining permits	Up to 100 miles	Large capacity; one company; multiple sites	Same as above, plus these mines are active with mine permits and ongoing development that compromises any storage of waste

Name	Acreage	Lifespan (years)	Capacity in Cubic Yards (cy) Yearly/Lifespan Volumes	Access	Tipping Fee ($)	Limitations	Distance from Conowingo (mi)	Option Pro's	Option Con's
(5) Eastern Industries Sites (Pennsylvania)	--	Unknown	They have not replied to multiple inquiries	Road, rail	--	PADEP regulations; mining permits	Up to 100 miles	Large capacity; one company; multiple sites	Same as above, plus these mines are active with mine permits and ongoing development that may compromise any storage

* Acceptable Pumping Distance
** 11 Miles from Safe Harbor, Acceptable Pumping Distance

Hydraulic Dredging

Hydraulic dredging is using a hopper dredge or a cutterhead dredge to remove sediment. The basic concept is like vacuuming the riverbed with about 80 percent water and 20 percent sediment being retrieved. If using a hopper dredge, the dredge is self-propelled and is used to collect sediment using what is known as a drag arm and filling a bin on the dredge called the hopper. The dredge then delivers it to a site where the material is dumped via using a split hull, (opening the hopper part of the dredge and letting the material fall out) or removing the material from the hopper, usually by re-slurring the material and pumping it to another location (i.e., a beach or into a nearby placement site). The capacity of hoppers also varies from about 1,000 to 5,000 cubic yards. You can move a lot of material, but while the dredge is moving to the offloading site, no dredging is occurring.

Hydraulic cutterhead dredging uses the same concept but has a cutterhead in lieu of a drag arm. The cutterhead is basically round and has teeth on the outside perimeter to loosen the sediment as it is circularly turning. A pump connected to the cutterhead then draws in the sediment and water and sends it to a large pump on the dredge; it is then pumped out through a pipeline. The pipeline runs from the dredge to its final placement position. The dredge is not really self-propelled but moves slowly via a series of spuds. The dredge is usually identified by the size of the pump discharge diameter (i.e., 16-inch, 20-inch, etc.). The pipeline is usually plastic, but can be made of metal. The pipeline comes in certain lengths and are fused or connected to form longer lengths. These additional lengths must be added as the dredge moves farther from the placement site. A decent-sized dredge can pump for about 14,000 feet, and then it would have to use a booster to pump farther. When a booster is used, the productivity can be reduced. It is easier to pump silt than to pump sand. Some dredges can be delivered by truck and placed or assembled in a water body.

There are only a couple of quarries near enough to use a pipeline directly. One hurdle is pumping uphill since it takes more power to overcome the head. The heavier the material, the less productivity is obtained. If you are just bypassing the dam and releasing downstream, you must find an area that will move the material. However by releasing downstream, you may be covering benthic organisms and/or SAV (submerged aquatic vegetation). It may be possible to construct and island downstream using hydraulic but most likely the perimeter of the island would need some type of containment. If pumping into a quarry, the water may need to be decanted. That may entail another pipeline to return the effluent to the river.

Based on removing 1,000,000 cubic yards a year, the distances to the suggested placement sites, the environmental sensitive time of year to dredge, it may be necessary to use multiple dredges to perform the work. It may take simultaneous work at all three dams.

Mechanical Dredging

Mechanical dredging consists of some type of excavator which could be located on shore but most likely would be mounted on a barge. The barge would be pushed with tugs to wherever dredging needed to occur. The mechanism for removal is via a clamshell, which has two sides and comes together to grab sediment; a bucket which is like a scoop to retrieve the sediment; and a backhoe or excavator which also scoops. The piece of equipment used for excavating comes in various sizes. The volume of a bucket may be 1 to 3 cubic yards, an excavator 3 cubic yards and clam shells can vary but a typical one could be about 8 cubic yards. These are somewhat typical and can be much smaller and larger.

Once the material is excavated, it must be placed somewhere. The material will be somewhat cohesive and will have water dripping from the bucket. Some buckets may have holes in it to allow more water to be released, and some buckets can be environmentally tight as to not allow any water to be released. The material will then be placed in another container. This could be directly into a truck (unlikely), onto a scow for transport to an offloading site, or into a container on a barge for further offloading. At the offloading site, you will need an excavator to clean out the scow and either place it in a site for further drying (site must be within the excavator' reach) or into a truck for delivery. A typical truck will hold about 10 to15 cubic yards of material. The truck will have to be watertight, so it won't drip onto the roads. Once it reaches its destination, it would have to unloaded (typically just dumped) and then back for another load.

Dredging 1,000,000 yards a year would mean about 100,000 truckloads of material. At the receiving site, there may be a tipping fee that could be paid by the yard or truckload and could add significant costs ($10-$30/cubic yard, or higher). Some places only will take the material if it is really dry. In that case, you will need to find several storage sites large enough (500,000 cubic yards is about 65 acres if using 10-foot-high dikes. The material would need to be turned to speed drying. This is usually done with a low-ground-pressure dozer. It would then have to be re-loaded onto trucks and then delivered to its final destination.

Drying

A lot of landfills and quarries want the material to be dried. This can happen in a number of ways. Material mechanically dredged could just be piled somewhere and allowed to air dry. This will take a lot of land and a lot of time. Although mechanically dredged material will not contain the amount of water as hydraulic-dredged material, it still needs to dry and needs a large amount of land to spread or stack the material. It will also be subject to atmospheric conditions and get rewet during rainstorms. To get the material to dry quicker, it should be actively managed. This could involve turning the material over to expose wetter conditions, digging trenches along the sides to encourage water to drain to those areas, or a combination of both. If you have water collecting at the site, you may need to dispose of the standing water to promote faster drying. Once dry, the material then could be rehandled and sent to its final destination. Every time you re-handle the material, it adds costs.

For hydraulic dredging, you would need to construct a dike about 10 feet high but will only use 8 feet of the dike height for the water-sediment combination. As the slurry is being pumped into the site, the effluent (water) must be returned after meeting water quality standards. This is usually done by a pipeline, and is gravity-fed to a nearby water body that will convey it eventually to the Bay. In some circumstances, it could be pumped back to the source. The level of water at the site is controlled by a series of boards within the dike weir. As boards are pulled, more water escapes and if too much water is escaping, you add boards to slow down the outflow. After most of the water is decanted off the sites, you may have to manage the dredged material similar to the mechanical method. The material will form a crust but you must get the water from within. After the crust is formed, it may be dry enough for some landfills. Some quarries may even allow both water and sediment to remain in the quarry if there is room, but that is very unlikely.   Once the material is dried, it can be hauled to a different site and the dike prepared for the next cycle of material.


Proud Past
Dynamic Future
BALTIMORE DISTRICT

LSRWA Scope

- Develop Sediment Management Strategies including concept design and costs
  - 1. Watershed Strategies – reduce sediment from watershed (i.e. BMP's, etc.)
  - 2. In-reservoir strategies
    - **A. Dredging/bypassing/innovative re-use**
    - B. Alter reservoir operations

Island Creation

- Teardrop islands in the Susquehanna River
- Creation in the Susquehanna Flats

Fringe Wetland Creation

- Material used to create wetlands along Susquehanna River
- Used for sediment already behind dam and to prevent further sediment build-up
- Common USACE practice

Pump Downstream

- Bypass option
- Allows sediment to relocate to starved areas of the Upper Chesapeake Bay
- Hydraulically pump material past dam and into Susquehanna Flats and northern Chesapeake Bay

Abandoned Mines

- Similar process has been completed by rail
- Multiple locations available in Pennsylvania

Smith Island Restoration

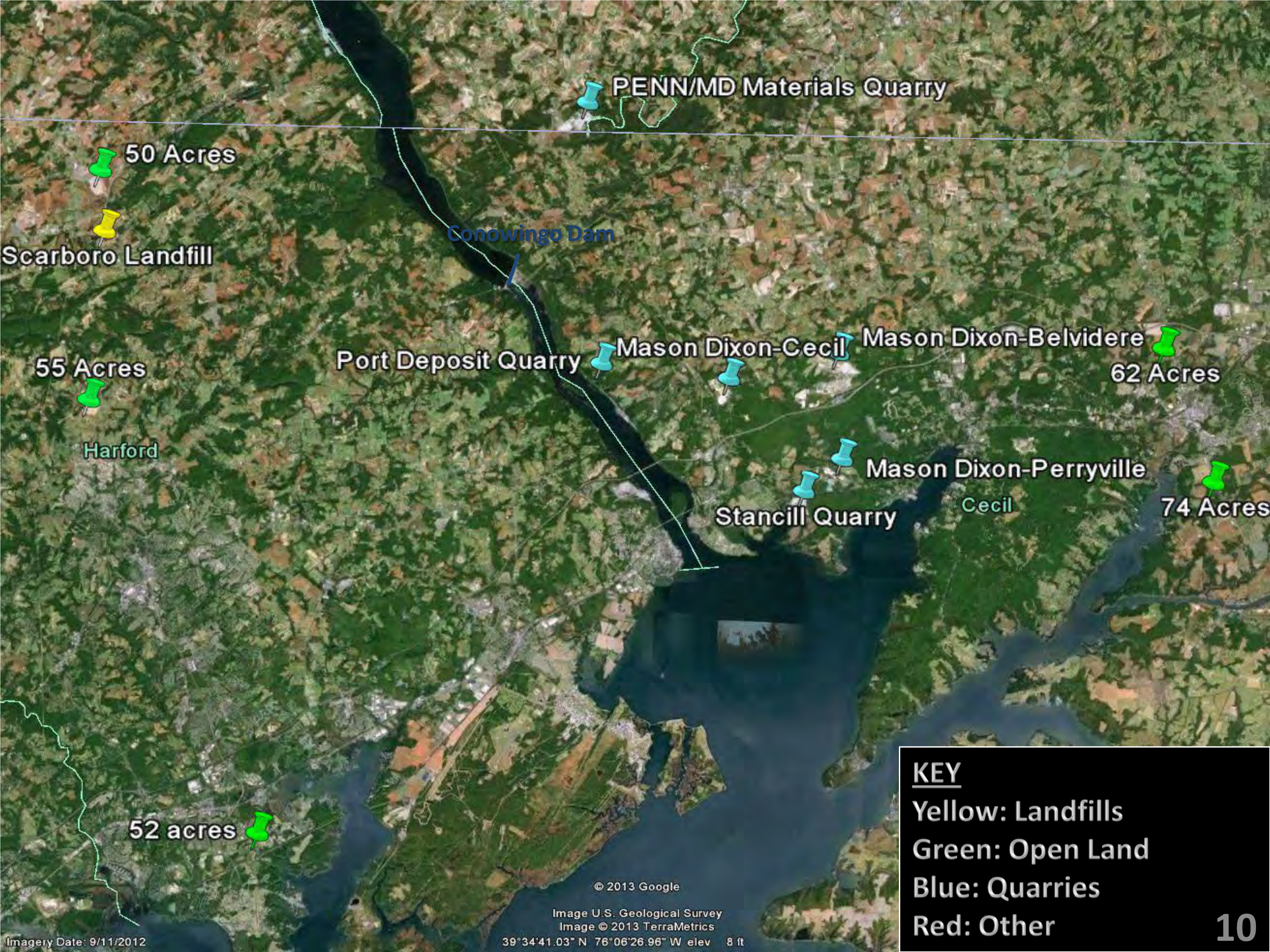
- Smith Island on MD/VA border in the Chesapeake Bay is eroding
- Would be used in conjunction with wave attenuation program
- Sandier materials only

Shirley Plantation

- Thousands of acres available
- Abandoned mine reclamation on site
- Mechanical or hydraulic dredging opportunities

Open Water Option

- Release Downstream
- Pump Downstream
- Pooles Island
- Ocean Placement
- Wolf Trap and Rappahannock, VA



KEY

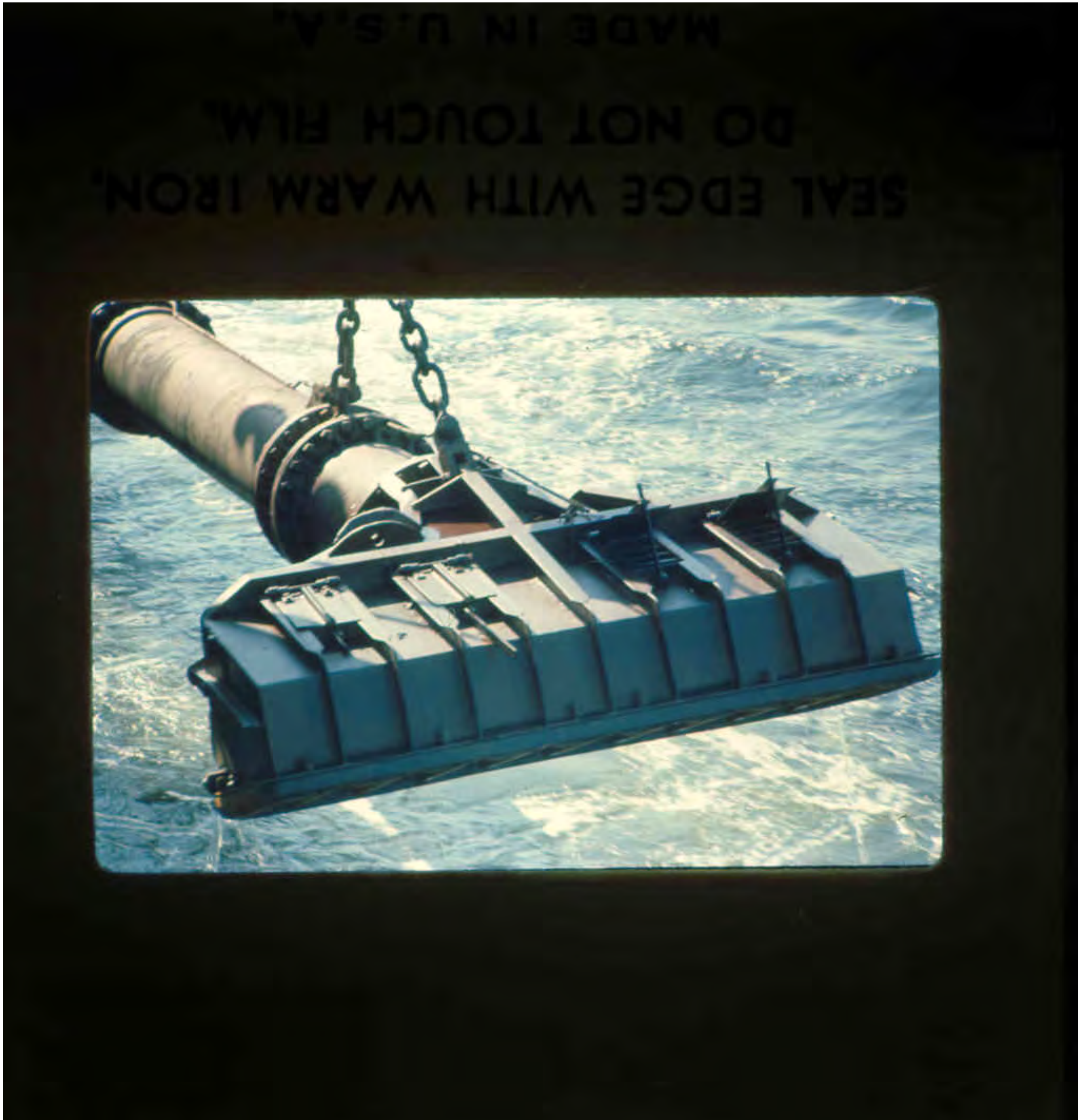
Yellow: Landfills

Green: Open Land

Blue: Quarries

Red: Other

HYDRAULIC DREDGING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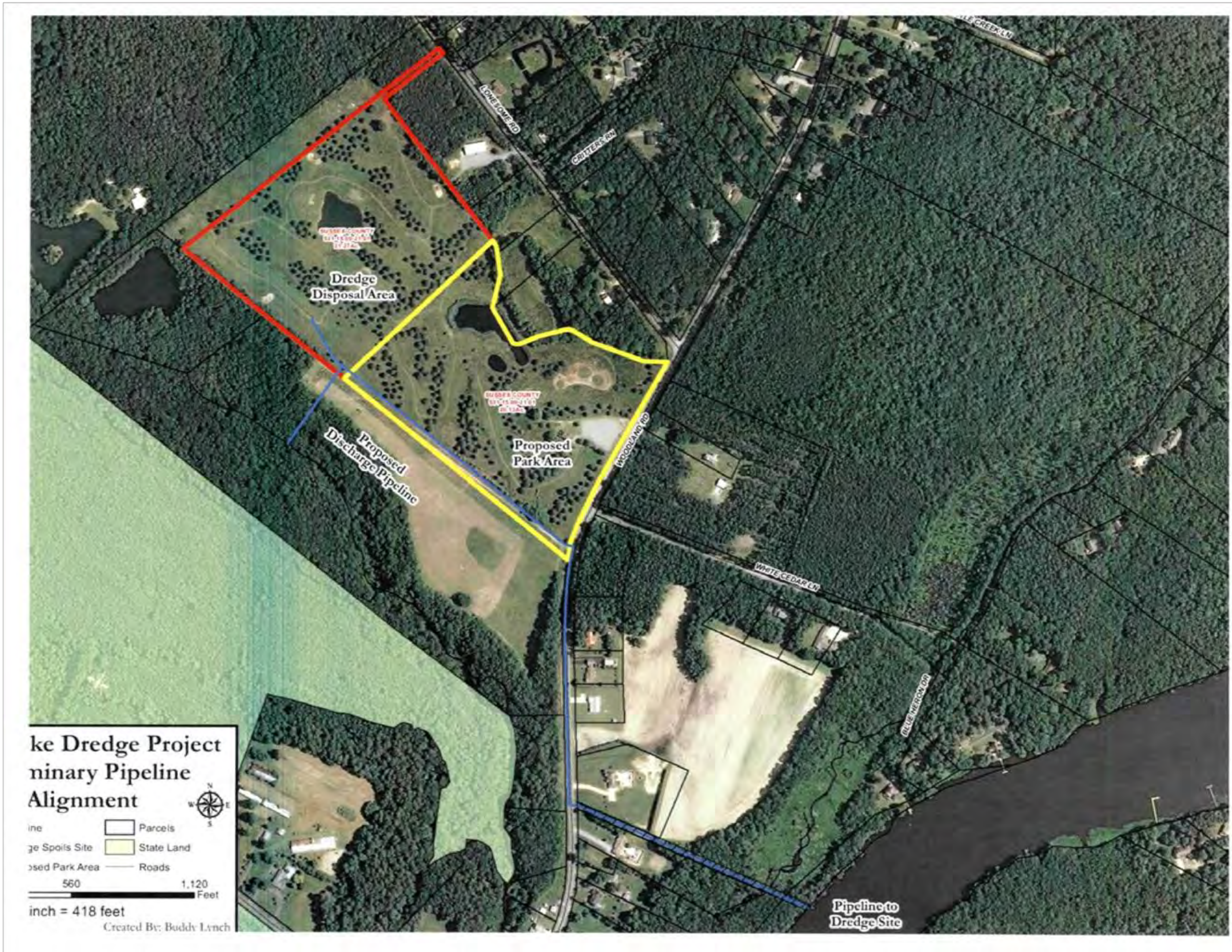


LONESOME RD
CRITTERS LN
WOODLAND RD
WHITE CEDAR LN
BLUE HERON DR
Dredge Disposal Area
Proposed Park Area
Proposed Discharge Pipeline
Pipeline to Dredge Site
ke Dredge Project
ninary Pipeline
Alignment
N
W
E
S
ine
Parcels
ge Spoils Site
State Land
osed Park Area
Roads
560
1,120
Feet
inch = 418 feet
Created By: Buddy Lynch

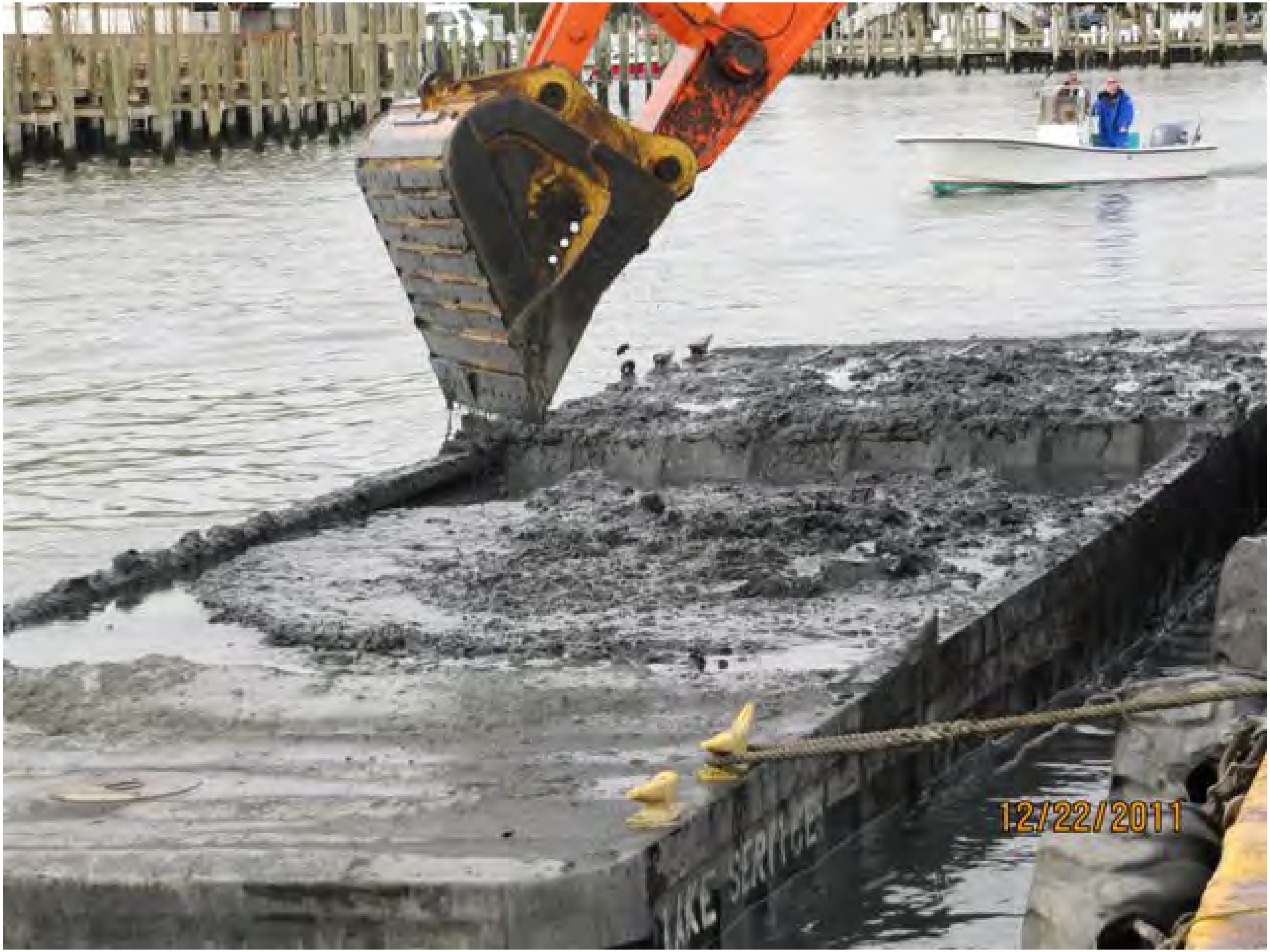

CITY LIMITS
0


CAT
CAT
DEERE
Hertz
03/12/2013


03/04/2013


02/27/2013

MECHANICAL DREDGING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CAT
D36
CAT
05/26/2007


12/20/2011


Langmaid Rd
Langmaid Rd
500 ft
200 m

Photograph by Wendy McPherson, U.S. Geological Survey.

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Lower Susquehanna River Basin Sediment Assessment: Sediment Bypass Tunnels Early Feasibility Assessment

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Sediment Bypass Tunnels: Overview

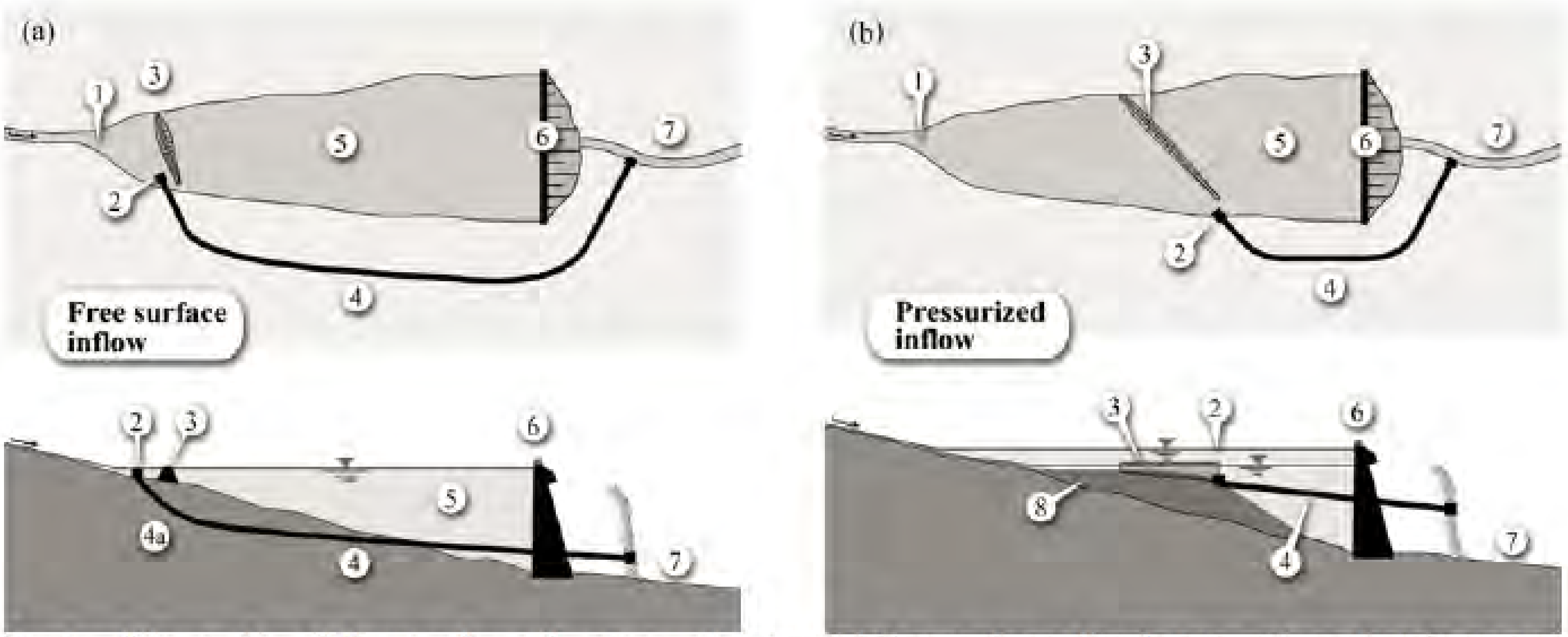

Fig. 2 Scheme of two different sediment bypass tunnel systems (a) Free surface inflow, location of tunnel intake at reservoir head; (b) Pressurized inflow, location of the tunnel intake downstream of reservoir head. 1) Reservoir head. 2) Intake. 3) Guiding structure. 4) Sediment bypass tunnel. 4a) Acceleration section. 5) Reservoir. 6) Dam. 7) Tailwater. 8) Aggradation body.

From Auel and Boes 2011

Sediment Bypass Tunnels: Summary

Advantages:

- Long-term sediment management solution
    - Extends reservoir life from 50 to 500 years
- Run-of-river sediment loads (mass & texture)

Disadvantages/Potential Concerns:

- No solution for stored sediments
    - ?but long-term benefits?
- Cost
- Technology in development

Bypass Tunnel Effects as Asahi Dam, Japan

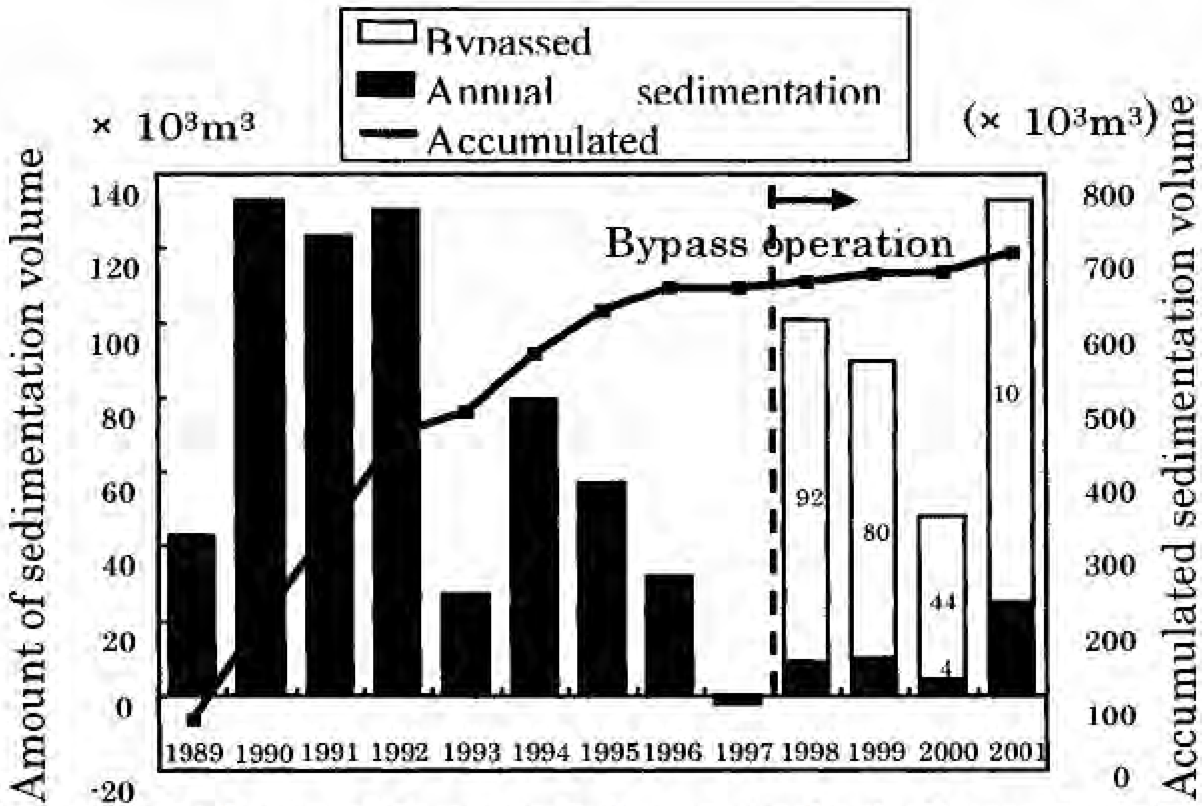

Fig. 5 Effect on the Reduction of Reservior Sedimentation by the Bypass Tunnel(Kataoka 2003)

Sumi et al 2004

Sediment By-Pass Tunnel Research Gaps: Optimal Design & <u>Material</u>

Miwa Reservoir sediment by-pass tunnel

Name	Country	Tunnel Completion	Tunnel Cross Section, B x H in m^2 (ft^2)	Tunnel Length in m (miles)	General Slope (%)	Design Discharge in cms (cfs)	Operation Frequency	Dam Description	Gross Storage Volume in Reservoir (m^3)	Catchment Size in km^2 (miles^2)	Cost
Nunobiki	Japan	1908	2.9 x 2.9 (9.5^2)	258 (0.16)	1.3	39 (1,400)		Gravity dam completed in 1900, 33.3m (109ft) high	0.76 M	9.8 (3.8)	
Asahi	Japan	1998	3.8 x 3.8 (12.5^2)	2,350 (1.5)	2.9	140 (5,000)	13 times per year, transports ~80% of sediment	Arch dam completed in 1978, 86.1m (283ft) high	15.47M	39.2 (15.1)	
Miwa	Japan	2004	2r = 7.8 (25.6)	4,300 (2.67)	1	300 (10,600)		Gravity dam completed in 1959, 69m (226ft) high	29.95M	311 (120.1)	
Matsukawa	Japan		5.2 x 5.2 (17.1^2)	1,417 (0.9)	4	200 (7,000)		Gravity dam completed in 974, 84.3m (277ft) high	7.4M	60 (23.2)	
Koshibu Dam	Japan							Arch dam completed in 1969, 105m (344ft) high	58M	288 (111.2)	
Yahagi	Japan				IN DESIGN			Arch dam, completed 1970, 100m (328ft) high	80M	504.5 (195)	
Sakuma	Japan							Gravity dam completed in 1957, 155m (509ft) high	327M	4,156 (1605)	
Egshi	Switzerland	1976	2r = 5.6 (18.4)	360 (0.2)	2.6	74 (2,600)	10 days per year	Gravity dam completed in 1949, 40m (131ft) high	0.4M	108 (42)	
Palgnedra	Switzerland	1974	2r = 6.2 (20.3)	1,800 (1.1)	2	110 (3,900)	2 to 5 days per year	Gravity dam completed in 1952, 72m (236ft) high	4.26M	138 (53.2)	
Pfaffensprung	Switzerland	1922	A = 21 (68.9)	280 (0.17)	3	220 (7,800)	200 days per year	Arch dam completed in 1921, 32m (105ft) high	0.15M	392 (151.4)	
Rempen	Switzerland	1983	3.5 x 3.3 (11.5 x 10.8)	450 (0.3)	4	80 (2,800)	1 to 5 days per year	Gravity dam completed in 1924, 32m (105ft) high	0.5M	66 (25.5)	
Runcahez	Switzerland	1961	3.8 x 4.5 (12.5 x 14.8)	572 (0.4)	1.4	110 (3,900)	4 days per year	Gravity dam completed in 1961, 33m (108ft)high	0.48M	55 (21.2)	
			Arch: 4.4 x 4.68	973		170	Designed for 1	Arch dam,		900	

Takayama Dam, Japan
Reservoir Sediment Mng't Assessment

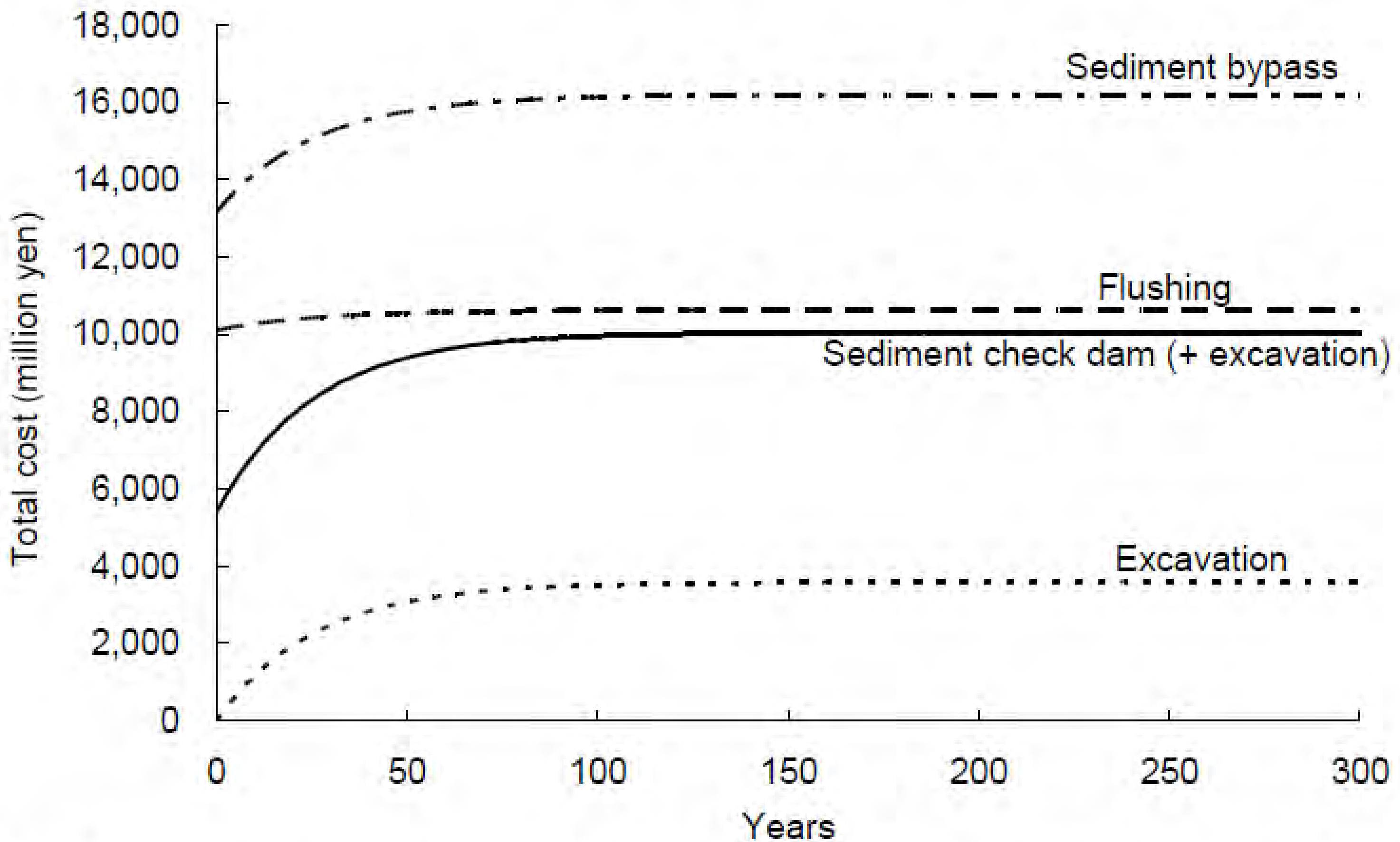

Fig.5 Takayama Dam: Change Over Years of Total Cost by Each Sedimentation Countermeasure

Takayama Dam Japan
Reservoir Sediment Management Assessment

Management Action	Implementation Costs	Maintenance Costs	Annual sediment removed from reservoir (m^3/year)
Dredging		\$10.3M / excavation (\$366 / m^3)	53,380
Check dam (including excavation)	\$56.5M	\$1.1M / excavation (\$42/ m^3)	28,123
Flushing, with gate	\$105.5M	\$230K / year	46,770
Bypass for sediment flushing	\$138M	\$1.3M / year	36,410
Dry excavation		\$26 / m3 \$ 800K / year	53,380

RESERVOIR SUSTAINABILITY WORKSHOP LAKEWOOD, COLORADO, JULY 10-12, 2012: "The cost of these alternatives is not well known, but no reservoir sediment management will eventually result in substantial dam decommissioning costs and either the loss of project benefits or increased costs of future water storage."

Sediment Bypass Tunnels: Value Depends on Goals

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‘Global’ Trending Goals:

- Protect water storage capacity
- Protect turbines
- Restore sediment supply (textured-based load) for down-gradient habitat

LSRWA Goals

- Protect down-gradient water quality

LSRB Reservoir Sediment Mng’t: Bypass Tunnel Option

Preliminary Assessment:

If water quality & habitat impacts to the Bay (indicated by TSS, TN, and TP obs) are our sole concerns, then bypass tunnel system likely will not offer much more benefit from ‘run-of-river, equilibirum conditions. Scour hazard still exists...at least initially.

After scour event, however, long-term management strategy emplaced, with delivery of more ‘holistic’ sediment texture composition.

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Lower Susquehanna River Watershed Assessment
Draft Reservoir Operations Alternatives Summary
May 10, 2013

1.0 Introduction

The loss of sediment storage capacity behind the three dams on the lower Susquehanna River, namely Safe Harbor, Holtwood and Conowingo, has been gaining considerable attention in recent years. Safe Harbor and Holtwood are considered to already be at steady-state. Conowingo is expected to reach steady-state in the near future. Many typical, sediment management strategies involve structural, mechanical, or upland/riverine Best Management Practice (BMP) actions. In some cases, there may be opportunities to implement reservoir operations measures to meet sediment management objectives.

2.0 Purpose and Need

As part of the comprehensive assessment of sediment management strategies for the lower Susquehanna River, potential reservoir operations alternatives need to be considered. The sections below describe existing dam infrastructure and operations, typical reservoir operations alternatives for sediment management, implementation considerations and constraints, and conclusions regarding the utilization of reservoir operations to manage sediment in the lower Susquehanna River.

3.0 Existing Dam Infrastructure and Operations

To evaluate reservoir operations alternatives for sediment management in the lower Susquehanna River, it is important to understand existing dam infrastructure and operations. These attributes are directly linked to implementation considerations and constraints, and conclusions regarding the feasibility of various alternatives.

3.1 Safe Harbor Hydroelectric Station

Safe Harbor Hydroelectric Station (Safe Harbor) has an installed electric generating capacity of 417.5 megawatt (MW) and a maximum licensed hydraulic capacity of 110,000 cubic feet per second (cfs). Lake Clarke has a surface area of 7,424 acres and a usable storage capacity of 47,850 acre-feet. The normal pool elevation range is from 224.2 to 227.2 feet. The dam contains 3 double leaf regulating gates and 28 flood gates. The water depth on the gate sill is 32 feet. Safe Harbor does not have a minimum flow requirement.

3.2 Holtwood Hydroelectric Station

Holtwood Hydroelectric Station (Holtwood) currently has an installed electric generating capacity of 107 MW and a total hydraulic capacity of approximately 31,500 cfs. The Federal Energy Regulatory Commission (FERC) recently issued a License Amendment for expansion of the capacity at Holtwood. Construction began in 2010 and, when completed, will result in a total electric generating capacity of 196 MW and hydraulic capacity of 61,460 cfs. Lake Aldred has a surface area of 2,400 acres and a usable storage capacity of 14,700 acre feet. The normal pool elevation range is from 163.5 to 169.75 feet. The dam is an overflow-type structure raised by wooden flashboards and an inflatable rubber dam. No flood gates are installed at the dam. As part of the License Amendment, Holtwood agreed to supply Conowingo with a continuous inflow of 800 cfs, and a daily volumetric flow equivalent to 98.7% of Conowingo's minimum continuous flow requirement, aggregated over a 24 hour period, or net inflow.

3.3 Conowingo Hydroelectric Generating Station

Conowingo Hydroelectric Generating Station (Conowingo) currently has an installed electric generating capacity of 573 MW and a hydraulic capacity of 86,000 cfs. Conowingo Pond has a surface of 8,625 acres and a usable storage capacity of 75,400 acre feet. FERC license requirements allow Conowingo Pond elevation to fluctuate from 101.2 to 110.2 feet. The normal pool elevation range is from 104.7 to 109.2 feet. Conowingo currently has 7 Francis turbines (~6,700 cfs/each) and 4 Kaplan turbines (~9,700 cfs/each). Flow over the ogee spillway sections is controlled by 50 stony-type crest gates. Each crest gate has a discharge capacity of ~16,000 cfs at pond elevation 109.2 feet and is 22.5 feet high. The dam also contains two regulating gates that have a discharge capacity of ~4,000 cfs per gate at pond elevation 109.2 feet and are 10 feet high. Each gate is lifted vertically by crane and can be set either fully open or fully closed with no intermediate setting. The total discharge capacity of the gates is ~808,000 cfs.

The current minimum flow requirements for Conowingo were established through a settlement agreement in 1989 between the station owners and resource agencies. The minimum flow requirements are:

March 1 – March 31	3,500 cfs or natural river flow (Marietta gage)
April 1 – April 30	10,000 cfs or natural river flow (Marietta gage)
May 1 – May 31	7,500 cfs or natural river flow (Marietta gage)
June 1 – September 14	5,000 cfs or natural river flow (Marietta gage)
September 15 – November 30	3,500 cfs or natural river flow (Marietta gage)
December 1 – February 28	3,500 cfs intermittent, 6 hours on/off (Marietta gage)

The estimated dam leakage of 800 cfs is not counted toward these minimum flow requirements. Currently, as part of the FERC relicensing process for Conowingo, the resource agencies and Exelon are working toward establishment of new flow management requirements.

The Conowingo Pond presents complex operational constraints. Many competing uses, ranging from public water supply to power generation, set parameters for fluctuation of water levels. Beyond FERC license requirements, additional factors influencing water level management include:

- Summer weekend recreation level of 107.2 feet;
- Minimum Muddy Run operation level of 104.7 feet;
- Peach Bottom Atomic Power Station (PBAPS) cooling problems at 104.2 feet;
- Minimum Chester Water Authority (CWA) withdrawal level of 100.5 feet;
- PBAPS license requirement to shut down at 99.2 feet;
- Minimum Baltimore withdrawal level of 91.5 feet.

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4.0 Reservoir Operations Alternatives for Sediment Management

4.1 Sluicing

Sediment sluicing is the evacuation of sediments from a reservoir by passing water and sediments through outlets located at the low-level of a dam. The objective of sluicing is to minimize sediment deposition and maximize sediment through-flow. Sediment sluicing also removes sediment by either completely scouring deposited sediment in the vicinity of the sluice gates or lowering the general level of deposits upstream. Sluicing requires timing of the release to periods to high volume, high sediment concentration inflows to the reservoir.

4.2 Density Current Venting

Density current venting is defined as a gravity flow of turbid water under water of different density. The density difference being a function of the differences in temperature, salt content or silt content of the two fluids. Density currents occur when sediment laden water enters an impoundment, plunges beneath the clear water and travels downstream to the face of the dam. When the density current is strong enough and lasts long enough, the sediment laden water can be discharged through low-level outlets. The venting of density currents has long been considered an effective means of reducing the rate of reservoir silting, especially in impounding reservoirs. Obviously, the method is applicable only in reservoirs where, and when, such density currents occur, and their high carrying capacity can be used to pass sediment through reservoirs.

4.3 Flushing

Flushing is another operational method for managing sedimentation in reservoirs. Flushing takes advantage of the flow itself without using external energy to remove sediment from the reservoir. Flushing re-mobilizes sediments previously deposited in a reservoir by drawing down the water level and letting the water flow out through low-level outlets in the dam. Water flowing through the reservoir scours sediments and passes them through the dam. To effectively remove sediment with flushing, the water level in the reservoir needs to be kept low for some time while the flow rate is high. The objective of flushing is to remove sediments already deposited in the reservoir. Flushing can take place when conditions are relatively convenient to reservoir operations.

4.4 Agitation Dredging

Agitation dredging is generally defined as the removal of bottom material from a selected area by using equipment to raise it temporarily in the water column and currents to carry it away. There are a number of different methodologies that can be employed to provide the bottom agitation and selected based on site considerations and ultimate objective for dredging. Typical methodologies include hopper overflow, air bubblers, rakes, and drag beams. Once the fine sediment is suspended in the water column, it can be transported downstream via streamflow and passed through the dam by way of release operations.

5.0 Implementation Considerations and Constraints

The infrastructure and operational constraints associated with implementing reservoir operations measures to meet sediment management objectives in the lower Susquehanna River reservoirs are not insignificant. Structurally, none of the three hydroelectric dams contain outlet works that would permit sediment releases during favorable hydrologic conditions. Release of sediment through the turbines, in excess of what is transported normally during generation operations at higher streamflows, could cause significant damage. Existing gates at Safe Harbor and Conowingo are designed for flood operations and, as such, provide little opportunity for sediment management. Retrofitting the existing dam structures with sluice gates or other bottom outlet works would be difficult, at best, without compromising the dams' structural integrity. Structural retrofit options would also create a substantial cost burden that will be difficult to justify in light of other alternatives.

The reservoirs of the lower Susquehanna River represent a unique, interdependent hydrologic configuration from an operational perspective. Each of the three hydroelectric dams has limited hydraulic capacities, ranging from 61,460 cfs to 110,000 cfs. The combination of FERC-licensed operational water level ranges, fixed intake elevations serving water supply and nuclear plant cooling, and recreational water level requirements result in confined, active storage capacity at the three reservoirs. Deviating from FERC-licensed water level ranges could have significant cost and safety implications. Limited hydraulic and active storage capacities at each of the hydroelectric stations, essentially results in run-of–river operations during significant sediment transport events.

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The potential for flushing of the lower Susquehanna River reservoirs is also complicated by both structural and operational constraints. With the reservoirs located in series, flushing operations would need to occur conjunctively to avoid depositing upstream sediment in downstream reservoirs. A hypothetical scenario might involve drawing down Conowingo Pond to minimum pool elevation ahead of a high flow event in an attempt to mobilize additional sediment stored in the reservoir, thus creating a void for future deposition. Drawdown of the pool would significantly impact power generation and water supply operations. Given that 400,000 cfs is commonly accepted as the scour threshold for mobilizing stored sediment in the lower Susquehanna River reservoirs, historic streamflow records suggest optimal hydrologic conditions for flushing are likely to exist only 0.1% of the time. Assuming drawdown of Conowingo Pond was deemed feasible, which is not likely given competing demands and associated public health and safety concerns, the sediment mobilized during a flushing event, coupled with the sediment laden flood water yielded from the watershed, could pose an unacceptable sediment surge to Chesapeake Bay.

Agitation dredging could be considered an operational alternative when conducted in conjunction with typical or modified dam operations. This particular operation would focus on fine sediments typically concentrated in downstream portions of each of the lower Susquehanna River reservoirs. The bulk of agitated suspended bed sediment would be in the lower half of the water column. To transport the suspended material, hydropower intakes would need to be open at the highest flow possible, which is 86,000 cfs at Conowingo. At this hydraulic capacity, it is unlikely that there would be adequate flow velocity in the lower portions of the reservoirs to transport agitated sediment. To transport agitated sediment a flow of approximately 100,000 cfs would be needed. Flows only naturally exceed this threshold approximately 7% of the time in the lower Susquehanna River, significantly limiting the window for implementing this operation. Only fine silt and clay is likely to stay in suspension in route to the dam. Thus, the overall effect of agitation dredging will be extremely limited in terms of grain size impacted, locations targeted, area affected and total volume transported. Without sluicing gates in any of the three dams, agitation dredging will require release of the suspended fines through turbines which may increase damage to the turbines. These limitations, coupled with dredging/operations costs and objectionable transport of only fine sediment, render this alternative undesirable.

Ultimately, the primary purpose for each of the lower Susquehanna River dams is to provide hydropower. The Sediment Task Force Recommendations release in 2002 dropped the modified dam operations alternative from consideration as it would impact the primary purpose of electric generation and the potential benefits would be limited. While the dams serve public water supply and other needs, complicating operational parameters, they were designed and constructed exclusively for generating hydropower. As such, their limited storage capacity, outlet infrastructure, hydraulic capacity, and operational ranges are not well suited to implementation of reservoir operations alternatives for sediment management. During hydrologic conditions when natural river flow exceeds the hydraulic capacity of the powerhouses, the dams spill and sediment is transported downstream.

6.0 Conclusion

In certain settings, reservoir operations alternatives can be implemented to meet sediment management objectives. The lower Susquehanna River reservoir system is complex in terms of hydrologic conditions and water resource demands. The cumulative effect of competing water uses, operational limitations, and structural constraints discussed above render traditional reservoir operations alternatives infeasible. Furthermore, the limited spatial and volumetric effects realized through operational alternatives within the confines of these restraints do not justify the significant implementation costs required. Modifying FERC-licensed dam operations may also unduly impact the primary purpose of existing water supply and power generation projects with only limited potential benefits to sediment management. The combination of these factors warrant that reservoir operations alternatives be dropped from further consideration.

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WIP Scenarios and Nutrient Loads

Lower Susquehanna River Watershed Assessment
Quarterly Team Meeting
May 13, 2013

Lewis Linker
CBP Modeling Coordinator
linker.lewis@epa.gov

Scenarios Described:

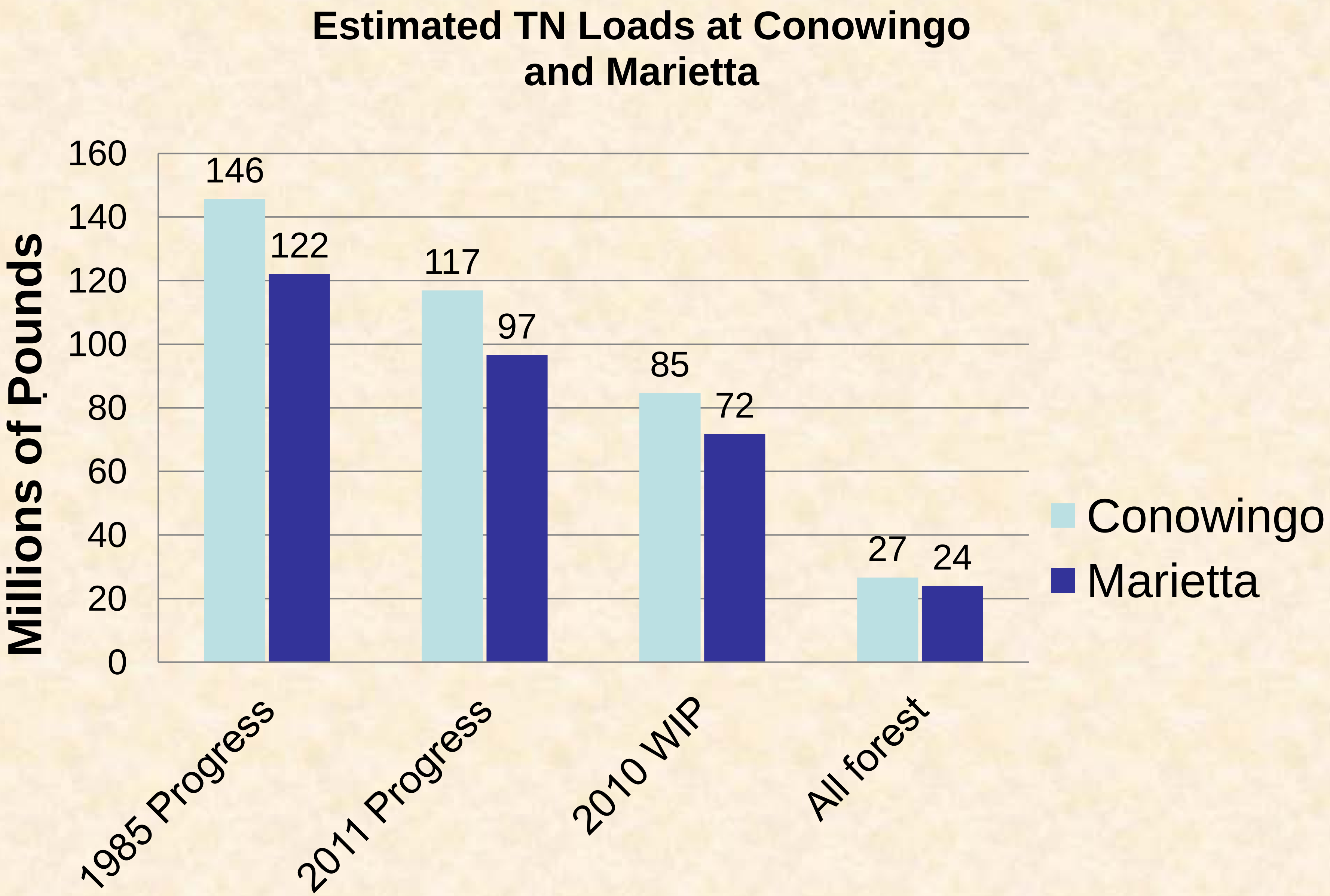
- **1985 High Historical Load Scenario –** uses estimated 1985 land uses, animal numbers, atmospheric deposition, point source loads and a 10-year 1991–2000 hydrology. The scenario has the highest historical delivered load estimates of nutrients and sediment to the Bay.
- **2011 Progress Scenario –** uses estimated 2011 land uses, animal numbers, atmospheric depositio, point source loads and a 10-year 1991–2000 hydrology.

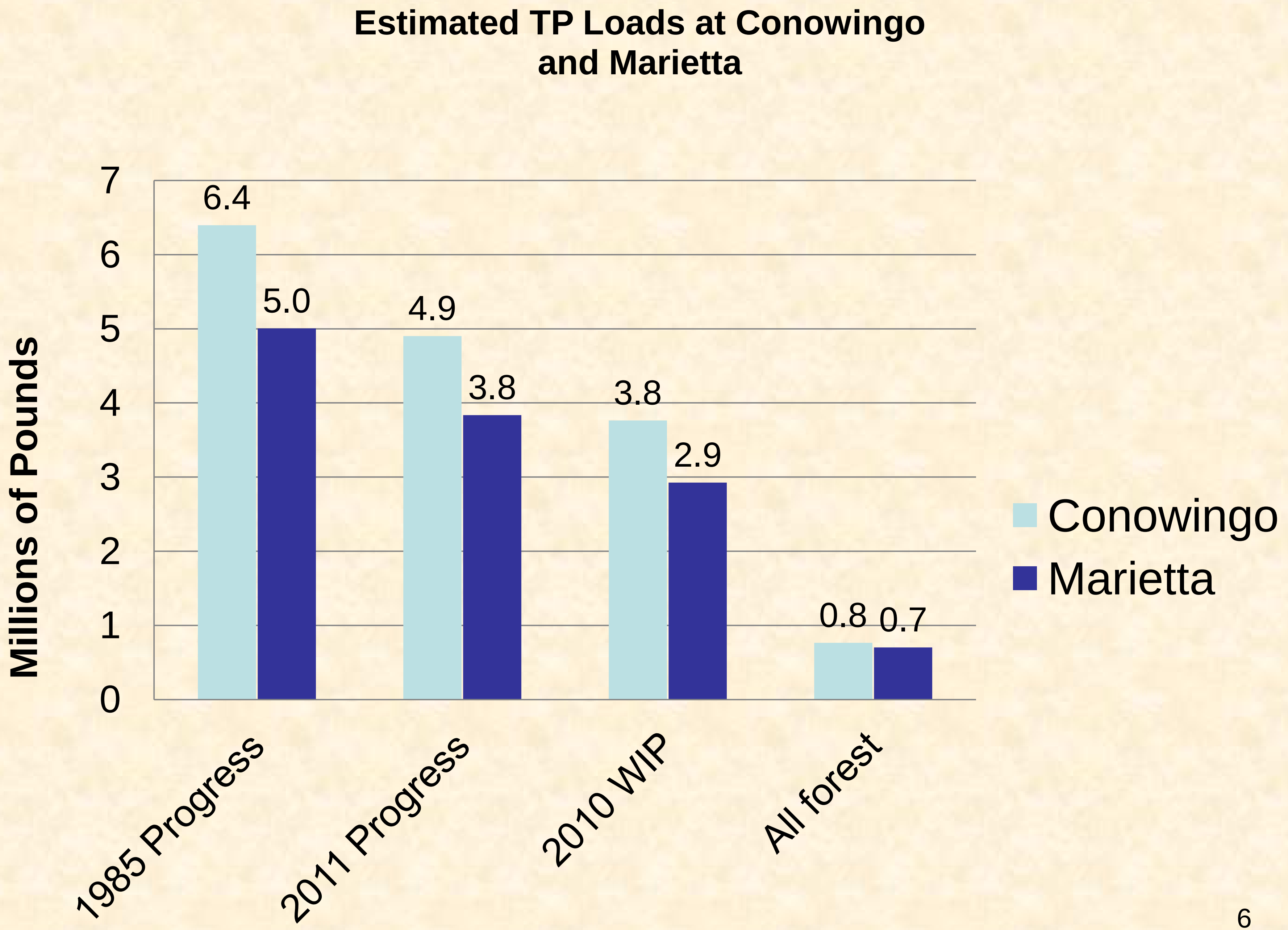
Scenarios Described:

- **2010 WIP -** estimates the nutrient and sediment loads of the jurisdictions' 2010 Watershed Implementation Plans (WIPs) throughout the Chesapeake Bay watershed. The scenario included accounting for all the WIP BMPs on a 2010 land use, and the 2010 estimated permitted loads for all the significant and nonsignificant wastewater dischargers that the watershed states have developed to achieve the states' Bay dissolved oxygen and chlorophyll water quality standards. Atmospheric deposition inputs were from the CMAQ 12-km grid with an estimated 2020 deposition and included estimated State Implementation Plans (SIPs) to reach the 2010 Air Quality Standards.

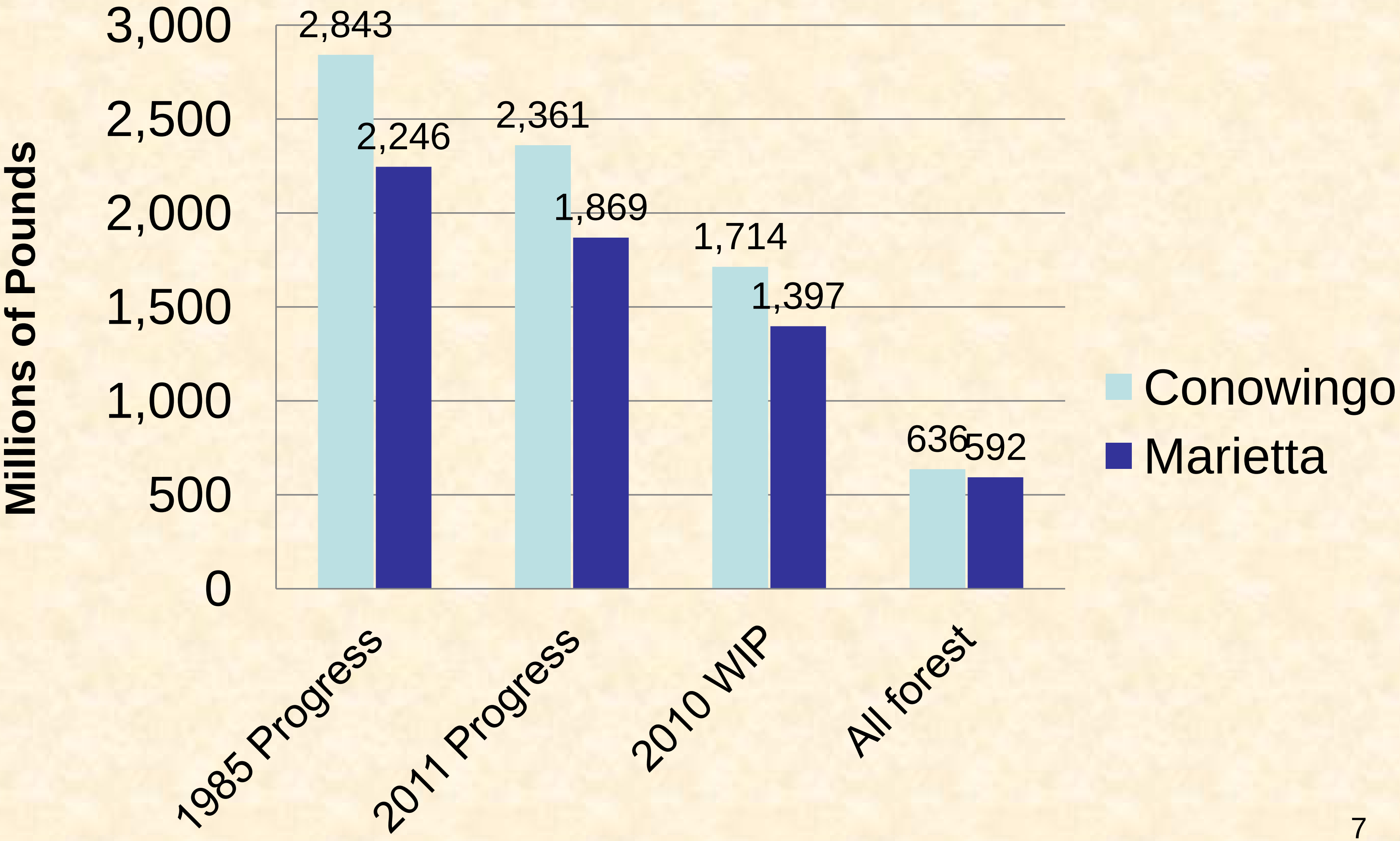
Scenarios Described:

- **All Forest Scenario -** uses an all forest land use and current estimated atmospheric deposition loads for the 1991–2000 period and represents estimated loads with maximum reductions on the land including the elimination of fertilizer, point source, and manure loads. However, this scenario has loads greater than a pristine scenario, which would have reduced input atmospheric deposition loads by about an order of magnitude.


Estimated TN Loads at Conowingo and Marietta
Millions of Pounds
160
140
120
100
80
60
40
20
0
146
122
117
97
85
72
27
24
1985 Progress
2011 Progress
2010 WIP
All forest
Conowingo
Marietta


Estimated TP Loads at Conowingo
and Marietta
Millions of Pounds
0
1
2
3
4
5
6
7
6.4
5.0
4.9
3.8
3.8
2.9
0.8
0.7
1985 Progress
2011 Progress
2010 WIP
All forest
Conowingo
Marietta

Estimated TSS Loads at Conowingo and Marietta



Framework of Sediment Management Alternatives