MEMORANDUM FOR THE RECORD

SUBJECT: Lower Susquehanna River Watershed Assessment
Quarterly Meeting, August 15, 2013

1. On August 15, 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 2:00 pm. The meeting attendees are listed in the table below.

2.

Lower Susquehanna River Watershed Assessment Team Meeting Sign-In Sheet			
August 15, 2013			
Agency	**Name**	**Email Address**	**Phone**
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City of Baltimore, DPW	Clark Howells	clark.howells@baltimorecity.gov	410-795-6151
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Chesapeake Bay Foundation	Beth McGee	bmcgee@cbf.org	443-482-2157
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Gomez and Sullivan	Kirk Smith		
Exelon - Gomez and Sullivan	Gary Lemay	glemay@gomezandsullivan.com	603-428-4960
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Exelon-Gomez and Sullivan	Tom Sullivan	tsullivan@gomezandsullivan.com	603-428-4960
Lower Susquehanna Riverkeeper	Michael Helfrich	LowSusRiver@hotmail.com	717-779-7915
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USFWS	Robbie Callahan	Carl.Callahan@fws.gov	410-573-4524
USFWS	Genevieve LaRouche	genevieve_larouche@fws.gov	202-341-5882
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USACE	Dan Bierly	daniel.m.bierly@usace.army.mil	410-962-6139
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USGS	Mike Langland	langland@usgs.gov	717-730-6953

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

Status of Action Items from May Quarterly Meeting:

a. Michael Helfrich will forward info to Danielle Aloisio on Funkhauser Quarry. *Status. Complete. No point of contact is available due to abandoned conditions, see response to "d" for more info.*

b. Claire will coordinate the next quarterly meeting for August 2013. Status: *Complete. Meeting occurred today.*

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

d. Bob Blama will call the Funkhauser Quarry to get more information on utilizing this as a sediment placement option. *Status Complete. While no POC was provided (it is an abandoned quarry), USACE did some preliminary calculations; volume is very limited, only 3 million cubic yards (mcy), and access to the quarry is a big concern. Michael Helfrich noted that he thought this would be a good place for a staging area. The LSRWA report/spreadsheets with potential alternatives have been updated with this info.*

e. 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. *Status. Complete. Chris Spaur updated the group on this item. He noted that he will prepare a write up for the report and will run it by Jeff Cornwell for comments. Chris noted that during study scoping in 2010/2011, water column and sediment nutrient-content data needs were discussed and evaluated. Anna and Chris coordinated with Carl Cerco, Steve Scott, Mike Langland, and Joel Bloomquist (USGS) for this purpose. The group determined that data on nutrient (and sediment) in water outflows from Conowingo Pond was inadequate, and collecting data to fill gaps was scoped into the study. It was recognized that it would be useful to have additional information on Conowingo Pond bottom sediment biogeochemistry, particularly with regard to phosphorus. However, it was determined that existing information/data was adequate for study modeling purposes, and it was decided to not undertake such investigations in light of need to control study costs. With regard to (P) phosphorus biogeochemistry, Carl had identified Jordan and others (2008) as presenting a concept applicable to utilize for our situation. P is generally bound to iron in fine-grained sediments in oxygenated freshwater and of limited bioavailability. Under anoxic/hypoxic conditions iron is reduced and P can become more bioavailable. P rebinds to iron in sediments if oxygen is again present. P adsorbed to Conowingo Pond bottom sediments would remain bound to those sediments in the freshwater uppermost Bay. In saltwater, biogeochemical conditions change. Jordan and others (2008) indicate that as salinities increase above about 3-4 ppt/psu (parts per thousand/practical salinity units, P is increasingly released from sediments and becomes mobile and bioavailable to living resources, which is likely due to increased sulfate concentrations in marine water water (e.g., Caraco, N., J. Cole, and G. Likens, 1989. Evidence for Sulphate-controlled Phosphorus Release from Sediments of Aquatic Systems. Nature 341:316–318.). The upper Bay remains generally below salinities of 3 ppt all year south to about the Sassafras River on the Eastern Shore and Bush River on the Western Shore.*

Chris noted that in the original scoping, the purposeful removal/release of sand from Conowingo Pond into the Bay was considered, but not the current bypassing alternative that could release fine-grained sediments into the upper Bay. The Bay model has determined that a release of Conowingo bottom sediments into the upper Bay in fall/winter would have fewer impacts to Bay water quality than in spring/summer, in part because the microbially-facilitated P release mechanisms occur more slowly in winter months. The winter timing allows for sediment deposition and P burial and long-term storage to occur before warm water conditions enhance P release in suspended and surface sediments. Additionally UMCES work has shown that there are less negative impacts when excessive flows enter the Upper Bay system during late fall/winter months because the life cycles for the species of concern are such that they are less susceptible to degraded water quality at this time. Mike Helfrich asked what depth P would need to be buried and how we would know whether waves would scour bottom. Chris said that MGS (1988) maps the upper Bay and shows that the channel on the west side as depositional so this region is presumably burial. Also, during the SAV growing season, large SAV beds would provide wave protection in the bed vicinity. During non-growing season when non-persistent SAV is absent, this wouldn't be the case though.

Chris offered to provide information summarizing 2010/2011 nutrient scoping to anyone that was interested, as well as copies of Jordan and others (2008). MGS report is available online:

Jordan, T.E., J.C. Cornwell, W.R. Boynton, and J.T. Anderson. 2008. Changes in phosphorus biogeochemistry along an estuarine salinity gradient: the iron conveyor belt. Limnology and Oceanography, 53(1): 172-184.

Maryland Geological Survey. 1988. The surficial sediments of Chesapaeke Bay, Maryland: physical characteristics and sediment budget. Report of Investigations No. 48. Maryland Geological Survey.

Beth asked about what species of phosphorus we are including in the water quality model. Carl said that his model, Chesapeake Bay Environmental Model Package (CBEMP) assumes a split of inorganic and organic P. This split is based on collected historical data. The model assumes that inorganic P is not bioavailable (as long as the water column is oxygenated); and that inorganic P stays bound to sediments. In the upper Bay conditions are oxygenated so this is a good assumption. Organic P gets split into two types: a smaller, more readily mobilized labile type and a refractory type which constitutes most of the organic P which decomposes so slowly it is considered essential unavailable to the biological community. Based on these conditions it is assumed that the the majority of P that comes over Conowingo is not bioavailable.

f. The group will review the baseline and future conditions summary spreadsheet and provide comments back to Anna Compton and Carl Cerco. *Status ongoing. Carl and Anna still are working on updating and finalizing summary spreadsheet. Anna will send out once completed.*

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. *Status: Complete. Lew will discuss this analysis; see Section 11.*

h. The LSRWA agency group will develop a screening process for reservoir sediment management options that are worth developing further. *Status Ongoing. Once the team sees modeling results, sediment management screening process can be further refined and lead to recommendations.*

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

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

<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 Seaman will keep team posted on FERC relicensing of Conowingo dam status. *Status: Ongoing. Shawn noted that currently MD and PA are negotiating with Exelon. August 2nd was last MD meeting. MD and PA will have some joint and also some separate meetings with Exelon in regards to relicensing process and negotiations.*

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

F. Anna Compton 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 the Chesapeake Bay Program (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 #6.*

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: Complete. It was determined that this task will not be completed at this time. Investigating the locations and depths from which sediment is eroded will not yield much. The problem is we have little or no information about the reactivity of bottom material. In the Chesapeake Bay modeling package (CBEMP), we partition particulate nutrients carried over the dam into various classes of composition and reactivity based on a combination of observations, experience, and judgment. If we are uncertain about the composition of material eroded from the bottom, we could do some sensitivity runs where we vary the partitioning and/or reactivity of the loads. However we couldn't state with certainty that the "sensitivity loads" would be any more realistic than the loads we are using now, but we could examine the risks involved in our current assumptions. This option is available for the future especially if more data is collected for instance for a feasibility level analysis of implementing some kind of management action.*

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 the assessment to provide a qualitative discussion of impacts. Bruce noted that in looking at what happened to SAV during TS Lee, high flows ripped up SAV from the periphery. It appears that there was damage from the physical impacts of the storm versus burial of SAV by scoured sediments. Mike Kemp is looking at other storm examples. Bruce will follow up with Mike Kemp and provide a write-up for report. Chris Spaur reminded the group that we don't have wave energy in our modeling. Chris can email past efforts on characterization of wave energy undertaken during the Chesapeake Bay Shoreline Erosion study.*

J. The LSRWA agency group needs to determine next steps for developing reservoir sediment management options. *Status: Ongoing. Representative alternatives were identified for costs; some alternatives identified for sediment transport/WQ modeling; results discussed in Sections 5, 6, 8, 9, and 10.*

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. Bruce noted that the Conowingo policy group met in April. There are no more meetings planned until more results from LSRWA are available.*

M. Exelon will review and provide comments on SRBC's write-up of altering reservoir operations as a sediment management strategy. Exelon will comment on the write-up to make sure dam operations are adequately covered. *Status Ongoing. John Balay will follow up with Exelon to ensure they have no further comments on reservoir operations section.*

Action Items from this (August 15) Quarterly meeting –

a. Chris Spaur will provide information summarizing the 2010/2011 LSRWA nutrient scoping to anyone that is interested, as well as copies of Jordan and others (2008) and a link to MGS report. This info also could be placed on the LSRWA website. Chris will also prepare a write-up on phosphorus biogeochemistry in the Bay for the LSRWA report.
b. Claire O'Neill will provide to the group all of the factsheets/ back-up documentation to show how costs were developed for each representative sediment management alternative.
c. Matt Rowe will look into Stancills quarry and their existing permits to see if they have any constraints or concerns with groundwater contamination. This may need to be marked as a limitation for this potential placement site.
d. Bruce Michael will be providing a write-up that lays out this watershed sediment management scenario in more detail in September.
e. Mike Langland will provide data to the group related to grain size and nutrients based on his analysis of the sediment core data.
f. Steve Scott will alter his graphs to depict areas of concern in red.
g. Carl Cerco will look into the suspended sediment and nutrient loads that Michael Helfrich has provided to determine if the loads need to be revised for his CBEMP modeling runs.
h. Anna Compton will work with the modeler's to develop a summary table compiling all sediment management modeling scenarios and results.
i. Anna Compton will draft up notes for the group's review and then post to the project website.
j. Claire O'Neill will set up a doodle poll to determine the date for next quarterly meeting which will be sometime in November.

3. Introductions - 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 FY13 federal budget funding arrived in July. This assessment received $300,000. While the assessment is still due $126,000 in Federal funds in FY14 to complete, if those funds are not readily available, the assessment has access to non-Federal funds to complete the analyses.

5. Update on Sediment Management Strategies – Costs - Claire O'Neill provided a handout, laying out a summary of costs for representative sediment management alternatives and an example "factsheet" which provides the back-up documentation to show how costs were developed for each representative sediment management alternative (Enclosure 2).

For the past year, the USACE-Baltimore District staff has been focused on developing concept design and costs for in-reservoir sediment management alternatives. At the February quarterly meeting, Bob Blama and Danielle Aloisio presented a matrix with many in-reservoir options. This matrix summarized field visits and telephone coordination that they had with potential placement sites. From this coordination, it was determined that the majority of potential placement sites that had accessibility and capacity were closer to Conowingo Reservoir. From that matrix, the assessment team selected a set of representative alternatives for the concept-level design and cost development for each of the categories to give us a sense of the costs for each category of alternatives. The alternatives came from four categories: (1) innovative re-use, (2) open water placement, (3) upland placement, and (4) watershed management. At this time, USACE is still waiting for Harbor Rock and MDNR to supply details for categories #1 and #4, so the presentation focused on alternatives in categories #2 and #3.

For the open-water and upland placement representative alternatives, Tom Laczo from the USACE staff compiled the available information and laid out possible logistics and infrastructure investment for three levels of one-time removal: 1 million cubic yards, 3 million cubic yards, and 5 million cubic yard to get a sense of unit costs for the various concepts. Each alternative has a detailed factsheet laying out the logistics. Items that were considered included the type of dredging, transport mechanism, the need for drying and consolidation of the material, type of placement, and real estate required. For example, depending on how you dredge, there is more or less water which impacts the amount of land you might need, time for drying and placement site.

The information was then compiled into a summary spreadsheet (one worksheet for each volume considered). During the meeting, Claire explained parts of the worksheet. Across the top are the four categories of representative alternatives, then under open water placement and upland placement there are individual alternatives. The first section physically describes those alternatives, including the type of dredging, the eventual placement site, and the transport method. Claire noted that for the hydraulic dredging alternatives involving trucking or barging, that large areas for drying the material would be required. Tom explained how rotational drying was considered if it were needed for any of the upland placement sites. For example, a temporary placement site could be divided into cells and while one cell(s) had material drying and consolidating other cells could receive new material while other cells could have material removed and transported to final destination. The concept is that cells would be rotated until the final destination placement site is at capacity. Tom noted that the drying time was aggressive (i.e., in reality, drying could take longer than assumed for this exercise).

The worksheet goes on to lay out some operational assumptions, investment costs, and annual/removal costs. Cost values are presented as a range between a low and high value. Tom Sullivan asked whether contingency was included in the calculations; Claire noted that a specific contingency was not added to the cost calculations but that the USACE staff took that into consideration in the low-high assessment. The worksheet illustrates that the annualized (one-time investment costs (based on a 50-year project life and the Federal project interest rate) are much less than the operational removal costs if the removal is done a yearly basis. In the lower half of the worksheet, the costs are calculated on a per cubic yard basis and major limitations are described. Claire noted that these limitations are not all encompassing and could be expanded. At the very bottom of the spreadsheet, the major assumptions are outlined. Anna noted that the tipping fees were based on recently collected data and there was discussion that these tipping fees could be negotiated. Claire reiterated that the costs developed are concept-level only, and that a feasibility study would be required to determine more detailed design and cost analyses if an entity was looking to implement any of these alternatives.

For the meeting, the attendees were provided with the summary spreadsheet and a sample detailed worksheet for an open water placement site. After hearing Claire's presentation, the meeting attendees were interested in seeing all of the detailed worksheets, so Claire agreed to follow up and provide those to everyone. Comments on the cost summary spreadsheet and the detailed worksheets were requested to be provided by 6 September 2013.

There was discussion on Stancills quarry as a potential placement site. There was a question if there would be water quality/groundwater issues. Bob Blama said when he talked with them, they said their permits were good. Matt Rowe said he could look into Stancills quarry and their existing permits. This may need to be marked as a limitation for this potential placement site. Matt noted that freshwater dredged material doesn't have the same constraints as saltwater dredged material (i.e., less potential for groundwater contamination).

Dave Ladd asked about combining of alternatives. Claire noted that the project partners will look into this further when they look to develop recommendations.

6. Watershed Sediment Management Strategies - Bruce Michael provided the group an update on the development of watershed sediment management strategies for LSRWA.

He noted that the TMDL process set nutrient (nitrogen and phosphorus) and sediment load allocations for each state, that when implemented by the year 2025, would eventually meet Bay water quality standards for dissolved oxygen, water clarity, and chlorophyll, an indicator of algal biomass. Each state was required to develop watershed implementation plans (WIPs) that provides reasonable assurance to EPA that they will meet their load allocations. The WIP defines specific best management practices (BMP) and how they are to be funded throughout the watershed.

The total sediment load allocation of 6,453.61M lbs/year for the entire watershed is not defined in the state WIPs. For the Susquehanna River watershed, Pennsylvania, New York and Maryland it is anticipated that the specific BMP implementation defined for meeting nitrogen and phosphorus load allocations are expected to exceed the sediment load allocation by 62M lbs/year by 2025 with full WIP implementation. The Chesapeake Bay Program watershed model (WSM) estimates that NY provides 317M/year lbs sediment load, PA 2,200M/year lbs sediment load and MD 68M/year lbs sediment load to the Bay.

An analysis was conducted to compare predicted 2025 WIP BMP levels (of TSS) to the predicted "E3" (everything, everywhere, by everyone) BMP levels (of TSS) in this basin. The analysis found that TSS load reductions (E3 scenario) above and beyond the Susquehanna River WIP BMP levels in the three states are 62M lbs/year. The TSS planning targets are the cap load allocations needed to meet clarity and SAV goals. Bruce noted that this delta of 62M lbs/year sediment should be considered in the LSRWA sediment management options.

It is estimated that the maximum additional delivered TSS load reduction (beyond the WIPs) is estimated to be 190M lbs/year. This includes the 62M lbs/year not accounted for in the WIPs. The "E3" scenario is a what-if scenario of watershed conditions. There are no cost and few physical limitations to implementing BMPs in "E3" scenario. Generally, "E3" implementation levels and their associated reductions in nutrients and sediment could not be achieved for many practices, programs and control technologies when considering physical limitations and participation levels.

For this analysis, it is assumed that the three states will meet their TMDL target load allocations for nutrients, and therefore, sediments. The EPA Chesapeake Bay Program provided data comparing non-wastewater BMP levels between the 2025 WIPs and a modified "E3" condition. "E3" conditions were primarily applied to the agriculture and forestry sectors since these are generally more cost-effective sectors with respect to TSS load reductions.

The BMP comparison lists implementation by major BMP category as absolute units, e.g., acres and as a percent level of implementation. The percent level of implementation is the cumulative planned acres compared to the total domain of acres available for the BMP. For several BMPs, this level would be 100 percent for the "E3" boundary condition.

For the objective of looking at acres in the lower Susquehanna River watershed beyond WIP implementation that might be available for additional sediment BMP implementation, Bruce and his team considered "upgrading" BMPs – rather than just additional implementation of BMPs specified in the current WIPs. The focus was on agriculture and forestry BMPs (opposed to stormwater) because of the relative cost-effectiveness.

In summary, the theoretical maximum additional delivered TSS load reduction (beyond the WIPs) is estimated to be 190M lbs/year. This is the model-estimated delta in loads between the two BMP scenarios – the 2025 WIPs and the 2025 WIPs with sediment "E3" scenario. Cost estimates for the BMP implementation, for both the 62 M lbs/year and 190 M lbs/year, are still under evaluation. The three states have different BMP cost estimates. As you approach the "E3" scenario, BMP implementation costs will theoretically increase as few acres will be available for implementation and the least expensive BMPs will have been implemented first. MDNR is working on developing a low and high cost range for BMP implementation.

As an initial rough estimate of sediment costs, MDE developed a list of Chesapeake Bay Program-approved BMPs, the load reduction, annual cost, cost efficiency and cost per pound. For each BMP, a low, medium and high cost per pound of sediment reduction was estimated. The low cost of cost per pound estimates ($3.87) were averaged and the high cost of cost per pound estimates ($105.72) for delivered sediment loads was utilized. Average costs were used to calculate a range of costs necessary to reduce additional sediment delivered to the Susquehanna River above and beyond WIP implementation using the "E3" scenario estimate of a 190M lbs/year sediment or 95,000 tons sediment/year.

The maximum available sediment per year that could be reduced by additional BMP implementation above and beyond the WIP implementation throughout the lower Susquehanna River Watershed is approximately 95,000 tons/year. This is about an order of magnitude less than what is estimated to flow over the Conowingo Dam into the Chesapeake Bay on a average annual basis (approximately, 1M tons/year).

Lee Currey noted that this analysis should make sure that the technical assumptions on costs for the period of analysis are consistent. Bruce noted that different BMP's do have different costs.

Bruce will be providing a write-up that lays out this watershed sediment management scenario in more detail in September.

7. Reservoir Transport - Mike Langland provided a presentation on reservoir transport which is included as Enclosure 3 to this memorandum. It is important to note that what was presented should be considered draft and is subject to change.

Mike first discussed his recent data compilation and findings on sediment transport (flood frequencies, sediment transport rates, trapping, and delivery). Overall, historically data there has been declining sediment transport into the Susquehanna river/reservoir system since the 1900's due to changes in sediment management throughout the watershed. He noted that historically as flow increases (i.e. during a storm event) sediment loads increase from the watershed and the loads that are scoured from behind the reservoirs increase as well. In general for the majority of flows, scour of sediments from behind the reservoirs influences about 22-25 percent of the total loads entering the Bay during an event (the rest is from the watershed). Scour from the reservoir occurs only when flows are above 380,000-400,000 cfs which has a reoccurrence interval of (1 in 4 chance or a "25-year storm").

Through time reservoirs have trapped more sediment. As the reservoirs fill with sediment they trap less sediment. Reservoir trapping efficiency has decreased from 75-80 percent to 55-60 percent currently (i.e. the amount of sediment that Conowingo is still currently trapping). In the future trapping efficiency is projected to maintain this 55-60% efficiency because storm scouring will still occur creating room for more trapping to occur on a cyclic basis. Mike noted that Tropical Storm Agnes was a massive change to the norm of trapping and scouring. He noted that this storm (1972) had about 15 million tons entering the reservoir system and those 15 million tons scoured by the storm plus an additional 15 million tons from the watershed entering the system. This is significantly higher loading and scouring than other observed storms.

Mike then discussed information that he collected on particle size distribution and location. He presented coring data collected throughout the reservoirs and focused on Conowingo cores. Through this analysis of data, he was able to determine the particle sizes and spatial distribution of the sediment. He observed that the trend is that there is a higher percentage of sand as you travel away from the reservoir. Fines (silts and clays) are being replaced with sands. For example in the lower portion of the reservoir in 1990, the area had about 5 percent sand; in 2012 it is projected to have about 20 percent sand. There was discussion of the bed armoring over time. Heavier material takes more time to remove (higher storm flows required). Presumably storms remove the silts and clays (easier to transport) leaving behind the heavier sands. For example, it is estimated that fines begin to move out of the reservoir when flows are around 250,000 cfs but sands do not start to move until flows are more like 500,000–700,000 cfs. Approximately, 400,000 cfs is an average of the flow it takes to scour sediment out of the reservoirs when you take into account all particle sizes.

We are not going to see much change in trends as Conowingo enters an equilibrium state. Trapping efficiency (55-60%) won't change and there will not be a whole lot of difference in the amount of loads we see entering the Bay now from the reservoir than we could anticipate in the future.

In summary, long-term sediment transport rates into/out of reservoirs from the watershed are declining due to improvements in sediment/nutrient management in the watershed. Historical data indicates decreasing trapping efficiency over time. Increasing discharge (flows) results in increasing scour (i.e. more sediment scoured and added to total Bay sediment/nutrient loads).

When flows are 400,000-700,000 cfs approximately 23 percent of the total load to Chesapeake Bay is from scouring of sediment from behind the dams; the remainder is from loading from the watershed. Overall sand is moving and displacing fines down-gradient in Conowingo Reservoir. If this trend continues, fewer silts and clays (fines) will be scoured in future events due to a combination of reasons, first, deposition onto the bed may be reduced due to changes in water column settling velocities as the reservoir continues to fill, and second, the state's WIP plans likely will result in less fines transported into the reservoirs in the future. While spatially the areas of Conowingo reservoir where conditions are suitable for fines to be deposited would remain the same as today, the volume deposited could be less. However, fines would be scoured more readily under lower flows (however still fairly infrequent events, 250,000 cfs or greater) thus likely increasing conveyance of fines over the dam under lower flow conditions. Because these lower flow conditions occur more frequently than higher flow conditions (250,000 cfs vs. 400,000 cfs or greater), we'd expect a trend of less volume/mass of fines building up in the reservoir to be available for scour during these higher flow conditions (more infrequent events). Thus, during major scouring events there could be a trend of reduced fines being scoured.

Conowingo Reservoir is in or close to dynamic equilibrium phase (~93 percent filled). Even at 93% full the trapping efficiency still remains at 55-60 percent. Conowingo will never be at 100 percent full due to periodic storm events scouring sediments creating room for more trapping. Consequently, this "dynamic equilibrium" is what state the reservoir is in now and will most likely remain into the future.

There was discussion on the percent of coal that is in these sediments. Mike noted that coal is considered to be either sand or silt in this analysis depending on its particle size; therefore, some of the sand and silt could be coal. There was discussion on the depths of the cores taken. Mike noted that x-ray equipment is utilized to analyze the cores. Mike's analysis methods will be included in his technical report write-up.

There was a question if it was possible to characterize phosphorus trends (associated with grain size). We need to connect this analysis with Bob Hirsch (USGS) findings. Mike will provide data to group related to grain size and nutrients.

Mike presented some additional data looking at estimated scour that the modeling has predicted compared to actual scour that has been observed from collected data before and after storm events, and specifically scour thresholds in the system. Scour threshold is a term that the modelers have been using to describe the average rate of flow required to begin scouring sediments out of the reservoir system. ADH predicts that the scour threshold is between 380,000-400,000 cfs. The USGS scour threshold computation based on data collected from past events, is around 400,000 cfs.

In general fines, start to move around 250,000 cfs but 400,000 cfs is when a real increase in scour and large amounts of sediment loads are observed.

8. Sediment Management Modeling - Steve Scott provided a presentation on sediment transport and various sediment management scenarios which are included as Enclosure 4 and Enclosure 5 to this memorandum. It is important to note that what was presented should be considered draft and is subject to change.

The first modeling scenario that Steve went over was a run on the ADH model looking at the sediment management alternative of agitation dredging. The goal of agitation dredging is to transport bed sediments through the dam (outlet structures) by re-suspending reservoir bed sediments. This procedure requires high pressure water jets or diffusers to re-suspend bed sediments upstream of the dam, and then adequate flow velocity to transport re-suspended sediment through the dam's outlet structures. Sediment-transport ability is a function of sediment particle size and bed shear stress. Steve used the ADH model to compute: bed shear stress for varying flows through Conowingo; shear velocity to evaluate turbulence required to maintain sediment in suspension; computed percentage of sediment remaining in suspension as a function of flow. His findings were that a minimum discharge of 150,000 cfs is required to ensure that sediments are transported through the dam during agitation dredging. He noted that flows greater than 150,000 cfs occur on an average of 12 days per year in this system. Also these high flows come most often in spring when we don't want sediment in the system because that is a critical time of year for living resources.

The next modeling scenario that Steve went over was a dredging sediment management scenario. The goal of dredging is to reduce scour potential (the amount of sediment available to be transported during a storm event) and increase deposition in the reservoir. The analysis methods included using computed sediment transport through Conowingo with 2011 bathymetry and 2008 – 2011 Susquehanna River flows; the removal of 3 million cubic yards from a depositional area 1.0 to 1.5 miles above the Conowingo Dam; then re-computing sediment transport within the dredged area; and finally comparing the results (2011 bathymetry vs. 2011 bathymetry with dredged area). Steve noted that the dredge area was selected because large amounts sediment still naturally deposit at this location. Results of this run were that with dredging there is a 3-percent reduction in scour (2.98 million tons vs. 2.71 million tons) over the 4 year flow record. Also dredging results in a 6-percent increase in sedimentation, i.e., deposition within the reservoir (4.02 to 4.28 million tons).

The next modeling scenario that Steve went over was a sediment by-passing sediment management alternative. Using the ADH model, he evaluated the impacts of sediment bypassing operations (dredging and passing sediment downstream through a pipe around the dam) on water quality below Conowingo Dam. The assumptions for this analysis were one run that included 2.4 million tons bypassed over 3 months time (90 days) and 2.4 million tons bypassed over 9 months time (270 days). Results of this run were that he observed an increase in suspended sediment concentration from 12 to 176 mg/l for the 90-day bypassing operation below the dam and an increase in suspended sediment concentration from 12 to 66 mg/l for the 270-day bypassing operation.

9. Sediment Transport Summary - Steve Scott provided a presentation summarizing ADH modeling findings which is included as Enclosure 6 to this memorandum. It is important to note that what was presented should be considered draft and is subject to change.

Steve has conducted several runs on with varying bathymetries of Conowingo Reservoir (1996, 2008, 2011, full, and 3 mcy removed). Over time the sediment load out of the reservoir (outflow) and scour load have increased while net deposition from the watershed to the reservoir has decreased. The 2011 and "full" bathymetry runs have essentially the same outflow, scour load and net deposition suggesting that the reservoir in its current state is at equilibrium. If the reservoir is dredged, it does have some influence on scour load and sedimentation. Steve noted 31 mcy of sediment (25 million tons) has deposited in Conowingo from 1996 to 2011.

Steve noted that as scour increases, net deposition decreases as bathymetry fills. Storms have a huge influence on the system. For example, Tropical Storm Lee provided 65 percent of the sediment load that year to the bay and 80 percent of that came from the watershed. He noted that the upper two reservoirs will scour and sediments will make their way down the system. He explained that the inflow load is total load that comes in from the watershed and upper two reservoirs. He also confirmed that 3 million tons is a good number to use as long-term average annual for inflow.

His findings were that: (1) scour load in Conowingo increased from 1.8 to 3 million tons from 1996 to 2011; (2) deposition in Conowingo decreased from 6 to 4 million tons from 1996 – 2011; (3) the 2011 bathymetry run compared to "full condition" indicates very little change in sediment transport i.e. the dam in its current state is acting full or at "dynamic equilibrium"; (4) dredging 3 million cubic yards resulted in a bed scour reduction (scoured sediment transported during a storm event) of 10 percent (3 percent per million cubic yards removed); and (5) dredging 3 million cubic yards resulted in a 1.3 percent reduction of outflow load (outflow load is inflowing load from watershed plus bed scour load) to the bay (0.44 percent per million cubic yards removed).

Based on comparisons between the 1996 and 2011 simulations for every million cubic yards dredged, the scour potential is reduced by 3 percent and the deposition potential increases by 6 percent; the net benefit of dredging to the Bay is reduction of scour plus increase in reservoir sedimentation. Dredging the reservoir back to 1996 bathymetry (this equates to a removal of 31 million cubic yards) has a net benefit of 2 million tons or load reduction to the Bay of 9 percent.

There was discussion on the sand deposition and coarsening downstream trend and how that would likely be expected even with a dredging program.

Chris suggested that Steve alter the coloring in his graphs because typically red signifies concern. He recommended that for bathymetry/hydrograph, darker blues should represent deep water and lighter blues represent shallow water, with shade/color of blue changing along gradient correlating to bathymetry. If the issue of concern is scour or currents, then to connote strong current or scour in color should probably follow convention: red means lots of concern, yellow less concern, and green no concern. This green/yellow/red convention can also apply to any other issues of concern that you might depict (excess sedimentation, contaminants, etc.). Strength of currents/scour could also be well-depicted using arrows of different sizes/boldness, etc. Steve will alter graphs to depict areas of concern with red.

10. <u>Water Quality Results</u> – Carl Cerco provided a presentation on his most recent modeling runs (CBEMP) which is included as Enclosure 7 to this memorandum. It is important to note that what was presented should be considered draft and is subject to change.

Carl noted that two dredging scenarios, removing 3 mcy, one time and removing 31 mcy were run to evaluate water quality effects. What remains to be run is a bypassing sediment management scenario of 3 mcy of sediment to predict water quality effects; this run is due to be completed in mid-September.

Carl explained that the CBEMP is run for 1991-2000 hydrologic period with WIPs in place. The model runs include loads from a major scour event (January 1996) which is added to the CBP WSM loads from the watershed. Scour is computed by ADH which utilizes 2008-2011 hydrology including TS Lee, and these loads are provided to Carl for input into the CBEMP model. Nutrient composition of solids (i.e., nutrients associated with sediments) is based on collected data during TS Lee.

Carl first presented a conceptual map of the system that he had developed. He explained that the system is event-oriented. The sedimentation rate of the reservoir system is independent of bathymetry of the reservoir (i.e, how full it is); however scour, (i.e., how much sediment is moved during a storm event) is strongly dependent on bathymetry. With the WIPs in place sediment loads to the system are decreasing as well as deposition of sediment in the reservoirs. Scour events pour sediments and nutrients downstream but also increase depths (thus affecting bathymetry) in the reservoir diminishing subsequent events by making more room for sediments to deposit.

Carl then went over modeling results. He noted that water quality focuses on bioavailable phosphorus. Monitoring station CB3 is important because if the TMDL is met here the Bay will just meet the TMDL threshold.

In general, dredging 3 mcy will improve summer-average bottom DO (dissolved oxygen) in the deep trench of the Bay, Potomac River, and Baltimore Harbor by 0.02 to 0.04 mg/l based on a 1996 scour event. Dredging 31 mcy will improve summer average bottom DO in the deep trench of the bay, Potomac River, and Baltimore Harbor by 0.04 to 0.06 mg/l based on a 1996 scour event. Dredging 3 mcy will reduce SAV growing-season chlorophyll a by 0.02 to 0.05 ugm/l in a large expanse of the bay, extending from Baltimore Harbor past the mouth of the Potomac River, based on a 1996 scour event. The magnitude of chlorophyll a reduction from dredging 31 mcy is comparable to dredging 3 mcy, based on a 1996 scour event. The improvement is more extensive and prolonged, however.

Carl noted that reductions in light extinction, averaged over the SAV growing season, obtained by dredging are limited on the order of 0.01 / m. The primary reason for the minimal impact is the occurrence of the storm in January. By the time the SAV growing season begins, the solids load from the storm has largely settled out. The improvements that do result are primarily downstream of the SAV habitat in Susquehanna Flats. This effect has multiple potential causes. The predominant reason is that the high flows associated with the January storm carry eroded material downstream, past the Flats, and into the turbidity maximum where material is trapped. Reductions in erosion caused by dredging therefore reduce the amount of particles and associated nutrients carried into the turbidity maximum."

There was discussion on why the 1996 storm event was used? There have been several larger flood events on record which would represent a worst case scenario. Carl noted that 1996 was utilized because it is in the hydrologic period that matches the TMDL model runs; also we have made runs and know that a June storm event is the worst case scenario (worst time of year) for an event. Michael Helfrich had concerns of showing this small amount of benefits to the public in light of the fact that the suspended sediment being utilized as input parameters for the model were low compared to data he had seen before (he had provided the source from PA). Carl noted he would look into the loads and data that Michael had provided previously to determine if the loads need to be revised for his modeling runs.

There was discussion on how the modeling runs will tie into the sediment management strategy development and concept costs. Anna and Claire noted that the sediment management strategy development was an exercise to develop unit costs and determine how some of these strategies could be implemented and they became "representative" sediment management alternatives. Many other alternatives or variations of these alternatives could be explored. The modeling runs at this time do not match each of the developed "representative" strategies/alternatives. The modeling predictions inform the managers of the relative changes to the system of implementing some general variation of these strategies to help refine and understand how implementation of these different management actions will affect the Bay. This strategy development process will need to be further refined as more information from the modeling comes in and is understood.

11. What Does This All Mean? Stoplight Plots - Lewis Linker provided a presentation on his most recent modeling runs which is included as Enclosure 8 to this memorandum. It is important to note that what was presented should be considered draft and is subject to change.

Lewis noted that the "stoplight plot" analysis presented utilizes Steve Scott's ADH modeling predictions on loads from lower Susquehanna River reservoir system and Carl's recent CBEMP modeling scenarios predictions to assess what the water quality outputs do to meeting TMDL attainment throughout Chesapeake Bay in response to loading from the January 1996 scouring event. The past presentation in April did not utilize loads from the ADH modeling work and represented an increase in TP and TSS loads estimated in Hirsch (2012) for current infill conditions (50 percent TP and 100 percent TSS increase in load from Conowingo Pool).

TMDL allocations (and ultimately achievement of TMDL) for nutrients and sediments for the Bay were developed utilizing an airshed model and the Chesapeake Bay watershed model (WSM) to determine existing nutrient and sediment loads to the Bay as well as loads under different management actions. Outputs from the WSM model were than input into the Water Quality and Sediment Transport Model (WQSTM) of the Bay to determine the influence on Chesapeake Bay water quality from these loads. A criteria assessment procedure was used to evaluate the WQSTM predicted water quality effects to each segment of the Bay to determine if the predicted water quality effects (over space and time) met water quality standards for each segment, and if not how far off that segment was from meeting water quality standards.

Lewis noted that healthy living resource habitats are the base metric in determining what water quality (and associated TMDL allocations) should be. Water quality standards in deep water, deep channel, open water, and shallow water dissolved oxygen (DO) are key for protection of living resources in the Bay. Chlorophyll and SAV/clarity standards are also designed to protect living resources.

Lewis noted that in this most recent analysis the following scenarios were run:
(1) TMDL (WIPS implemented);
(2) TMDL with scour from Tropical Storm Lee, with nutrient levels scoured from January 1996 event;
(3) TMDL with scour from January 1996 event with nutrients scoured from January 1996;
(4) No January 1996 scour event;
(5) TMDL with Tropical Storm Lee levels of scoured nutrients with January event moved to June;
(6) TMDL with Tropical Storm Lee level of scoured nutrients with January Storm occurring in October;
(7) TMDL with January 1996 event level of scoured nutrients moved to June;
(8) TMDL with January 1996 event level of scoured nutrients moved to October.

Lewis evaluated the predictions of these modeling scenarios to see if water quality changes would prevent certain segments of the Bay from being in attainment per TMDL requirements.

When the WSM alone (his analysis in April 2013) is used to represent scour from the completely full state of Conowingo, loads are set at 250 percent (TSS) 100 percent (TP), and 0 percent (TN) above loads that we currently see now. That is, once Conowingo is "full" this is the amount of additional loads we could expect. What we have learned from recent ADH and CBEMP modeling runs is that a more complete estimate of the influence of Conowingo on Chesapeake water quality would fully include the episodic scour that occurs at flows greater than ~400,000 cfs.

Under the April 2013 stoplight analysis several Deep Water and Deep Channel DO segments were "red" i.e. not in attainment. The ADH/CBEMP modeling simulation is an improved representation of the dynamic nature of Conowingo scour/infill system with the simulation of the high flow event of the 1996 scouring event. With this scenario no effects from Conowingo are seen before a 400,000 cfs storm. Then the greatest influence on Chesapeake water quality is estimated during the contiguous 3-year period (1996-1998) immediately after the 1996 scour event and a subdued to no-effect influence is estimated in the subsequent 3 - year period of 1998 - 2000. Estimates with the simulation of the 1996 scour event are less detrimental in time and space than previous April 2013 estimates which represented more frequent loads of sediment and nutrients due to moderate flow events. At the (CB4MH) Deep Channel location the estimated effect of the 400,000 cfs event (January 1996 storm event) was a decrease in DO attainment of about 1% or less for the 3 years following the storm (using the 1996-1998 hydrology).

The No-Storm scenario provides an estimate of the influence high flow scour events like the 1996 storm event have on Chesapeake water quality and generally increase nonattainment of Deep Channel DO standards by about 0.5 to 1.5 percent. The January 1996 event transposed to June is the most detrimental to DO followed in decreasing influence by the January event, the October event, and the No-Storm event scenarios.

In the Deep Water area (CB4MH), no effects from Conowingo are estimated before a 400,000 cfs storm event, with greatest influence on water quality estimated during the contiguous 3-year period containing the storm, and a subdued to no-effect influence in the subsequent 3-year period after the storm. As in the Deep Channel, estimates with the current scenario method are less detrimental in time and space than previous April 2013 estimates. The estimated effect of the 400,000 cfs event (January 1996 storm event) was a decrease in DO attainment of 0.5% or less for the 3 years following the storm followed by a decrease in DO attainment of about 0.4% in the subsequent 3 year period.

For the Open Water DO water quality standard there is no change in response from Conowingo influence and full attainment of TMDL for all Conowingo scenarios is primarily due to reaeration of the surface waters represented by the Open Water DO standard.

In conclusion, the previous (April 2013) scenarios which assumed that once Conowingo is completely "full" we will see a 70 percent increase in P and a 250 percent increase in TSS and under current infi1l conditions have an estimated 50 percent increase in TP and a 100 percent increase in TSS (Hirsch, 2012) fail to fully represent the dynamic nature of large storm scour on Chesapeake water quality. The scour of Conowingo reservoir by a high flow event such as the January 1996 scour event under current infill conditions is estimated to have an ephemeral detrimental influence of at most about 1 percent nonattainment for a few years.

12. Future Modeling Scenarios – Anna Compton noted that currently there are no further modeling scenarios planned for Steve Scott (ADH); Carl Cerco (CBEMP) will be running two by-passing scenarios and Lew Linker (stoplight analysis) will be running by-passing and dredging scenarios. The goal is to complete all modeling runs by mid-September.

Anna Compton will be working with the modelers to develop a summary table compiling all sediment management modeling scenarios and results.

13. Wrap Up – Claire O'Neill reviewed the schedule for this effort which is included as Enclosure 9 to this memorandum. Claire noted that overall the study has kept on schedule up to this point. Activities occurring now include modeling sediment management scenarios which is scheduled to be completed in September unless new scenarios are developed. Concurrently sediment management strategies development is scheduled to be completed in September as well. All technical work and technical write-ups are scheduled to be completed by Mid-October and recommendations are to be developed by November. A draft report is scheduled to be compiled by the end of the calendar year with review commencing in January. The report will go through many iterations of review before it can be released publicly. The target date for a draft final report submitted for public review is August 2014. There was a question about peer review of the document. Claire noted that the document is required to go through USACE agency technical review (ATR) which will be various reviewers from outside of USACE Baltimore District. There is another level of peer review USACE has which is called Independent External Peer review (IEPR) which is non-USACE, technical review. This level of review is not required for LSRWA, it is normally required for high dollar decision/implementation documents. However, if a governor requests that a document goes through IEPR than that could prompt this type of review for LSRWA. .

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 November.

Anna Compton,
Study Manager/Biologist

Enclosures:
1. Meeting Agenda
2. Summary of Representative Sediment Management Alternatives.
3. Reservoir Transport – Mike Langland Presentation
4. Sediment Management ADH modeling – Steve Scott Presentation
5. Sediment By-passing ADH modeling- Steve Scott Presentation
6. Modeling Summary- ADH modeling Steve Scott Presentation
7. CBEMP modeling results- Carl Cerco Presentation
8. Stoplight analysis-Lewis Linker Presentation
9. LSRWA Schedule