September 11, 2017

Via email to: elder.ghigiarelli@maryland.gov

Elder Ghigiarelli, Jr.,
Deputy Program Administrator
Wetlands and Waterways Program
Water Management Administration
Maryland Department of the Environment (MDE)
1800 Washington Boulevard, Suite 430
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Re: Conowingo Hydroelectric Project, Application for Water Quality Certification, Application # 17-WQC-02

Dear Mr. Ghigiarelli:

Please accept the following comments on Exelon Generation Company's application for Clean Water Act Section 401 water quality certification ("Exelon Application"),[1] which Exelon is requesting as a necessary precondition of its related application to the Federal Energy Regulatory Commission ("FERC") for a new 50-year license for the continued operation of the Conowingo Dam Project.

FERC itself has acknowledged that one of the "primary issues" associated with relicensing the Conowingo Dam Project is the threat of "sedimentation effects on aquatic resources downstream of Conowingo dam, including the Chesapeake Bay."[2] Unfortunately, FERC has also made clear, through its inadequate study of that threat, that Maryland cannot count on FERC to impose conditions on the Project needed to prevent or offset Project-induced scouring of sediment concentrated behind the Dam.[3] Unless Maryland imposes such conditions, its water quality goals and pollution control measures could be undermined by catastrophic sediment and nutrient discharges during one or more predicted high-flow events during the

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[1] Exelon Generation, Section 401 Water Quality Certification Application, Conowingo Hydroelectric Project (FERC Project No. 405), Cecil and Harford Counties (May 17, 2017).

[2] Final Multi-Project Environmental Impact Statement for Hydropower Licenses, Susquehanna River Hydroelectric Projects (March 2015) at xxxviii.

[3] *Id*. at 139 (characterizing sediment as a "watershed-wide issue" and dismissing the profound effect of the Project in artificially concentrating sediment behind the Project's Dam).

requested license period.[4] But Exelon has failed to provide sufficient information about the current and future effects of the Conowingo facility's ongoing operation on water quality, and has failed to propose measures to offset those effects. Exelon has also failed to account for the additive effects of climate change upon sediment scouring, and Maryland must consider these impacts in its certification analysis. We therefore urge Maryland to either impose conditions requiring Exelon to participate as a financial partner in a specific plan for removing a minimum of 4 million tons of sediment from Conowingo reservoir annually until 100 million tons are removed, and for maintaining the same level thereafter. Alternatively, Maryland should deny the application due to its deficiencies.

I. LEGAL BACKGROUND

Section 401 of the Clean Water Act ("CWA") gives states the authority to review any federally-permitted or licensed activity that may result in a discharge to navigable waters, and to condition the permit or license upon a certification that any discharge would comply with key provisions of the CWA and appropriate state laws.[5] This expansive certification authority preserves a substantial role for the states in protecting water quality, even when permitting authority lies solely in federal hands. As the U.S. Supreme Court characterized it:

> State certifications under § 401 are essential in the scheme to preserve state authority to address the broad range of pollution… "No polluter will be able to hide behind a Federal license or permit as an excuse for a violation of water quality standard[s]. No polluter will be able to make major investments in facilities under a Federal license or permit without providing assurance that the facility will comply with water quality standards. No State water pollution control agency will be confronted with a fait accompli by an industry that has built a plant without consideration of water quality requirements."[6]

A. Application of CWA § 401

Pursuant to § 401 of the CWA, a state certification is needed when there is:

> Any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates

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[4] *See* USGS, *et al.*, Lower Susquehanna River Watershed Assessment, Maryland and Pennsylvania at 65, Table 4-3 (May 2015) (hereafter "LSRWA"), http://dnr.maryland.gov/waters/bay/Documents/LSRWA/Reports/LSRWAFinalMain20160307.pdf (setting forth the annual exceedance probability for various return interval flow events, with expected flow estimates for the flow gauge at Conowingo Dam).

[5] 33 U.S.C. § 1341(a)(1).

[6] *S.D. Warren Co. v. Maine Bd. of Envtl. Protection,* 547 U.S. 370, 386 (2006) (citation omitted).

> or will originate … that any such discharge will comply with the applicable provisions of sections 1311, 1312, 1313, 1316, and 1317 of this title.[7]

The term "discharge" has been broadly interpreted to include the release of anything that flows out, including discharges from hydroelectric dams.[8] The discharge also need not be certain; rather, the mere possibility of a discharge is sufficient to trigger the requirements of § 401.[9]

When § 401 applies to a project due to a potential discharge, the certification process applies to the "activity as a whole," not merely to the discharge itself.[10] Therefore, the certifying state must determine whether any aspect of the project (not just a discharge) would violate the relevant federal or state laws. In the case of a hydroelectric dam project, for example, a certifying state must apply the certification process to a wide range of actions such as the trapping of nutrients and sediment behind the dam, changes to stream flow and water temperature, increases in total dissolved gas levels below the dam, and the release of sediments and nutrients below the dam during both routine operation and increasingly common storm events.[11]

B. Procedure

Section 401(d) of the CWA directs states to certify § 401 projects only when the project activities would comply with all applicable federal and state laws. These laws include the federal effluent limitations (§ 1311), federal water quality related effluent limitations (§ 1312), state water quality standards and implementation plans (§ 1313), federal new source performance standards (§ 1316), toxic and pretreatment effluent standards (§ 1317), and "any other appropriate requirement of State law."[12]

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[7] 33 U.S.C. § 1341(a)(1).

[8] *S.D. Warren Co.*, 547 U.S. at 373.

[9] 33 U.S.C. § 1341(a)(1) (stating that certification is required when an activity "may" result in a discharge); *see also* U.S. EPA, *Clean Water Act Section 401 Water Quality Certification: A Water Quality Protection Tool for States and Tribes* (2010) at 4, https://www.epa.gov/sites/production/files/2016-11/documents/cwa_401_handbook_2010.pdf ("EPA § 401 Guidance").

[10] *PUD No. 1 of Jefferson County v. Washington Dept. of Ecology*, 511 U.S. 700, 712 (1994).

[11] Due to climate change, it is predicted that all parts of the U.S. will see increases in storm intensities, and the Northeast will also experience a 58% increase in the average number of days with very heavy precipitation. Garfin et al., *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment* (2013), at 6, 8, http://www.swcarr.arizona.edu/sites/all/themes/files/SW-NCA-color-FINALweb.pdf; Hall and Stuntz, *Climate Change and Great Lakes Water Resources* (Nov. 2007) at 6-7, http://online.nwf.org/site/DocServer/Climate_Change_and_Great_Lakes_Water_Resources_Report_FI.pdf.

[12] 33 U.S.C. § 1341(a)(1), (d).

If a project would not comply with the applicable laws, a state must either deny § 401 certification,[13] or conditionally grant certification with "any effluent limitations and other limitations, and monitoring requirements necessary to assure" compliance with the law.[14] If a state denies certification, the federal permit or license for the project may not be issued.[15] In this way, § 401 grants states the authority to halt projects that illegally harm water quality. Alternatively, in cases where specific permit conditions would ensure compliance with the law, a state may conditionally grant certification and these conditions would become binding limitations on the permit or license.[16]

States must complete their § 401 certifications within "a reasonable period of time (which shall not exceed one year) after receipt of [a certification] request."[17] If a state fails to act on a certification within a year's time, the certification process is deemed waived.[18] However, the waiver period only applies to the certification decision. Any conditions imposed on a § 401 certification need not be completed within a year's time and may extend into the licensing period and beyond.[19]

The federal agency responsible for issuing the permit or license may, by regulation, choose to impose a waiver period that is shorter than one year, but the certifying state has the authority to determine when the waiver period begins.[20] FERC's pertinent regulations maintains the one-year-long waiver period and provides for waiver only "if the certifying agency has not denied or granted certification by one year after the date the certifying agency received a written request for certification."[21] In the state of Maryland, a "written request for certification" must be a complete application which includes the information outlined in the Code of Md. Regulations ("COMAR") 26.08.02.10(B). Therefore, the Maryland Department of the Environment ("MDE") must make a decision on Exelon's application for certification for its FERC relicensing within

[13] *Id.* § 1341(a)(1).

[14] *Id.* § 1341(d).

[15] *Id.* § 1341(a)(1).

[16] *Id.* § 1341(d).

[17] *Id.* § 1341(a)(1).

[18] *Id*.

[19] *Alcoa Power Generating Inc. v. FERC*, 643 F.3d 963, 974 (D.C. Cir. 2011).

[20] *See, e.g., Ackels v. EPA*, 7 F.3d 862 (9th Cir. 1993) (noting that EPA's NPDES regulations require state certification within sixty days, but also noting that EPA had discretion to accept certification after sixty days); *City of Fredericksburg v. FERC*, 876 F.2d 1109, 1111-12 (4th Cir. 1989) (holding that the state of Virginia was permitted to impose its own filing procedures on certification requests and that the certification waiver clock never began in that case because the applicant never made a formal application for certification in accordance with Virginia's requirements).

[21] 18 C.F.R. § 4.34(b)(5)(iii).

one year of the date it received a complete application from Exelon that fulfilled COMAR 26.08.02.10(B), likely May 17, 2017.

Furthermore, Maryland regulations state that MDE must provide public notice of every application for certification, accept written comments on the application, and hold a public hearing when "(1) [t]he Department determines the activity requiring certification is of broad, general interest; or (2) The application for certification generated substantial public interest as indicated by written comments concerning water quality issues."[22] MDE has already indicated it intends to hold a public hearing on the Conowingo Dam relicensing § 401 certification.[23]

C. Scope of State Authority

States have extensive authority to deny or impose conditions during the § 401 certification process. As EPA has explained in recent guidance, "[c]onsiderations can be quite broad so long as they relate to water quality," and "[c]ertification may address concerns related to the integrity of the aquatic resource and need not be specifically tied to a discharge."[24] In addition to ensuring compliance with the statutorily enumerated provisions of the CWA (§§ 1311, 1312, 1313, 1316, and 1317), certifying states must assure compliance with "any other appropriate requirement of State law."[25] Courts have consistently interpreted this provision to mean that all state water quality standards must be satisfied.[26] State water quality standards include designated uses for water bodies,[27] as well as the quantitative (numeric) and qualitative (narrative) criteria needed to achieve the designated uses,[28] and anti-degradation.[29] Therefore, certifying states have the obligation to ensure compliance with not only numeric water quality standards (and the total maximum daily loads ("TMDLs") used to enforce them), but also mandates designed to protect recreational uses and aquatic life.[30] Indeed, courts have repeatedly allowed certifying states to deny certifications based on the need to comply with state water

[22] COMAR 26.08.02.10(C), (D).

[23] Maryland Department of the Environment, Public Notice, Proposed Relicensing of the Conowingo Hydroelectric Project (Aug. 8, 2017), http://mde.maryland.gov/programs/Water/WetlandsandWaterways/Documents/Conowingo-PN-Comment-Period-Ext-8-8-17.pdf.

[24] EPA § 401 Guidance, *supra* note 9, at 23.

[25] 33 U.S.C. § 1341(d).

[26] *See, e.g.*, *PUD No. 1 of Jefferson Co.*, 511 U.S. 700 (holding that state water quality standards, including minimum stream flow requirements, should be enforced through § 401 certifications).

[27] 40 C.F.R. § 131.10.

[28] *Id.* § 131.11.

[29] *Id.* § 131.12.

[30] *Anacostia Riverkeeper Inc. v. Jackson*, 798 F. Supp. 2d 210, 238 (D.D.C. 2011) (holding that a state's total maximum daily loads for a water body must ensure protection of all state water quality standards, including *all* designated uses and water quality criteria, in order to satisfy the CWA).

quality standards, including non-quantitative standards such as the protection of aquatic life and shellfish habitat.[31]

In the case of Exelon's application for certification, the legal mandate to expansively enforce all state water quality standards prevents Exelon from simply relying on the Chesapeake Bay TMDL to absolve itself of any obligation to address the sediment pollution from the Dam. The Chesapeake Bay TMDL did not include a wasteload or load allocation to accommodate discharges of sediment or nutrients scoured from behind the Dam, and did not purport to relieve Exelon of its responsibility for such discharges. MDE must instead look beyond the TMDL and independently ensure the project's sediment discharges do not interfere with attainment of the Chesapeake Bay TMDL, or with the designated uses which ensure support of estuarine and marine aquatic life and shellfish harvesting.[32] MDE must also ensure compliance with Maryland's narrative water quality standards which prohibit pollution by any material in an amount that would "[c]hange the existing color to produce objectionable color for aesthetic purposes" or "[i]nterfere directly or indirectly with designated uses," among other things.[33] In other words, MDE may not grant § 401 certification unless it imposes conditions which prevent the violation of all numeric and narrative water quality standards, and all designated uses.

D. Review of § 401 Certification Decisions

The federal permitting or licensing agency has no authority to review a state's decision about a § 401 certification. If a state denies certification, the federal agency may not issue the permit or license,[34] and if the state conditionally grants certification, all state conditions must be included in the permit or license without review.[35] Only a court can review the legality of state-imposed certification conditions.[36] Depending on the nature of the challenge, either a federal court or a state court may be the appropriate forum to review a § 401 certification decision.[37]

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[31] *See, e.g.*, *AES Sparrows Point LNG v. Wilson*, 589 F.3d 721, 733 (4th Cir. 2009); *Islander East Pipeline Co., LLC v. McCarthy*, 525 F.3d 141 (2d Cir. 2008).

[32] *See* COMAR 26.08.02.08(B) (designating the Lower Susquehanna as Class I-P and Class II in various segments); COMAR 26.08.02.02 (designating Class II waters as "Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting").

[33] COMAR 26.08.02.03.

[34] 33 U.S.C. § 1341(a).

[35] *Id.* § 1341(d); *see also American Rivers, Inc. v. FERC*, 129 F.3d 99, 102-111 (2d Cir. 1997) (holding that FERC did not have the authority to exclude any state § 401 certification conditions on a FERC hydropower license, and that only a court could review the legality of state-imposed certification conditions).

[36] *American Rivers, Inc. v. FERC*, 129 F.3d at 102, 112.

[37] EPA § 401 Guidance, *supra* note 9, at 31.

II. MDE SHOULD EITHER DENY CERTIFICATION OR ESTABLISH CONDITIONS ON ITS CERTIFICATION SUFFICIENT TO OFFSET PROJECT-INDUCED EFFECTS ON NUTRIENT AND SEDIMENT DISCHARGES.

A. Any § 401 certification for the Conowingo Dam Project should include conditions requiring Exelon to contribute to removal of sediment from Conowingo Reservoir.

The Conowingo Dam Project has profoundly altered the Lower Susquehanna River system. It has historically trapped an average of 50-67% of the annual sediment load (1.5 to 2 million tons),[38] along with the nitrogen and phosphorus attached to the trapped sediment. If not for the Conowingo Dam, this load would have been delivered to the Lower Susquehanna River and Chesapeake Bay at normal rates. Exelon incorrectly claims that the Conowingo Dam Project has functioned as a "best management practice" for the Chesapeake Bay, but this is an overly simplistic portrayal of the Project's effects. In fact, the Dam and its reservoir have produced an enormous artificial repository of sediment and associated nutrients that can be scoured by high flow events, re-mobilized, and delivered downstream by large storm-induced flows.[39] In fact, these scoured loads add additional pollutant loads at times when the downstream receiving waters are already vulnerable, receiving their heaviest loads of suspended pollution from the Susquehanna River Watershed.[40]

The threshold flow needed to produce scouring will be surpassed many times during the requested license period.[41] As the U.S. Geological Survey stated in a 2012 peer-reviewed report:

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[38] *See* Final Study Report: Sediment Introduction and Transport Study: RSP 3.15 (Aug. 2012) at 11, 14-15 ("FSR 3.15"), http://mde.maryland.gov/programs/Water/WetlandsandWaterways/Documents/ExelonMD/FERC/Conowingo-FRSP-3.15.pdf; *id*. at 58 tbl.3.2-1 (citing Michael J. Langland, *Bathymetry and Sediment-Storage Capacity Change in Three Reservoirs on the Lower Susquehanna River, 1996-2008* (2009) (hereafter "Langland (2009)"): sediment accumulation rate for 1996-2008 was 1.5 million tons/year; for 1959-2008 average rate was 2 million tons/year); *see also* FSR 3.15 app. F at 5 (Exelon's bathymetric survey of Conowingo Pond, estimating 1.45-1.69 tons deposited annually based on 2008-2011 average).

[39] *See* FSR 3.15 at i, 10-11; Michael J. Langland & Robert A. Hainly, *Changes in Bottom-Surface Elevations in Three Reservoirs on the Lower Susquehanna River, Pennsylvania and Maryland, Following the January 1996 Flood—Implications for Nutrient and Sediment Loads to Chesapeake Bay* (1997) (hereafter, "Langland & Hainly (1997)"); Langland (2009); Robert M. Hirsch, *Flux of Nitrogen, Phosphorus, and Suspended Sediment from the Susquehanna River Basin to the Chesapeake Bay during Tropical Storm Lee, September 2011, as an Indicator of the Effects on Reservoir Sedimentation on Water Quality* (2012) (hereafter "Hirsch (2012)").

[40] LSRWA at 78 (noting that proportion of scoured sediment loads increases with higher flows); *id*. Table 4-7 (Scour and Load Predictions for Various Flows in Conowingo Reservoir).

[41] LSRWA at 65, Table 4-3.

> The evidence presented in this report indicates that the predicted changes are not just a theoretical issue for future consideration, but are already underway. These changes in the reservoirs are already overwhelming the progress being made to reduce constituent loads from the Susquehanna River watershed. Therefore, efforts to reduce nutrient and sediment inputs to the Chesapeake Bay will need to include consideration of changes in the trapping of sediment entering, and scouring of sediment in, the reservoirs along with the management actions implemented upstream in the watershed.[42]

Thus, scoured loads deliver much greater quantities of sediment and nutrients to the Chesapeake Bay than the natural loading that would have occurred during the same flow events had the Project not been in place. Particularly in the case of very large storms – such as 25-year, 50-year, 75-year, and 100-year return interval flow events, for which there is a substantial to reasonable likelihood of occurrence during the requested license period, as discussed below – Project-induced scouring could overwhelm pollution reductions undertaken upstream in the Lower Susquehanna River watershed.

Indeed, the effects of climate change will likely lead to more frequent and severe scouring events at the Project. Over the past century or so, the Northeast (including the Chesapeake Bay region) has experienced increases in the average annual temperature, amount of precipitation, and amount of extreme precipitation events, and these trends are expected to continue and strengthen in the coming years due to climate change.[43] For example, the average temperature in the Northeast is expected to rise between 2.7 and 3 °F by 2035, between 3.6 and 4.8 °F by 2055, and between 4.7 and 8 °F by 2085, compared with the average temperature in 1971-1999.[44] In addition, the annual amount of precipitation in the Northeast is expected to increase between 2-7% in 2041-2070, compared with 1971-2000.[45] Finally, the frequency of extreme precipitation, defined as the number of days with over an inch of precipitation, is expected to increase by about 10-20% in the Chesapeake Bay watershed by 2041-2070,

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[42] Hirsch (2012) at 13.

[43] Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, and J. G. Dobson, 2013: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 9. Climate of the Contiguous United States, NOAA Technical Report NESDIS 142-9, *available at* https://scenarios.globalchange.gov/sites/default/files/NOAA_NESDIS_Tech_Report_142-1-Climate_of_the_Northeast_U.S_1.pdf ("Kunkel et al."); *see also* Raymond Najjar, *Climate Change in the Northeast U.S.: Past, Present, and Future*, The Pennsylvania State University, Chesapeake Climate Projections Workshop, March 7-8, 2016, available at http://www.chesapeake.org/stac/presentations/258_Najjar%20Climate%20Chesapeake.pdf ("Najjar").

[44] Kunkel et al., *supra* note 43, at 35, 38.

[45] *Id*. at 56.

compared with 1971-2000.[46] These significant climate-related impacts must be considered by MDE during the certification process because they will likely increase the predicted levels of scouring threshold exceedances that were originally assumed for the Project.

Moreover, MDE cannot rely on the Chesapeake Bay TMDL to account for the effects of climate change, and must independently analyze the best available climate projections for the region in order to account for these additive impacts. Fundamentally, MDE has a legal obligation to consider more than mere TMDL compliance (or noncompliance) because the agency must also analyze whether the Project as a whole will interfere with the river's designated uses and narrative water quality standards under the expected climate conditions in the coming decades.[47] The Chesapeake Bay TMDL does not analyze the effects of the Conowingo dam on Maryland's state water quality standards under any conditions, much less under the projected future climate in the Northeast, and this climate analysis is an essential component of the state certification process. Furthermore, any increases in nutrient and sediment pollution from the dam due to climate change were simply not considered in the Chesapeake Bay TMDL. To the extent the dam's effects were included in the TMDL, the TMDL's assumptions about pollution levels did not account for the additive effects of climate change. In fact, only a very vague and preliminary assessment of climate change was completed for the Chesapeake Bay TMDL as a whole in 2010, due to limitations in the modeling that was available at the time.[48] Although the TMDL's "Midpoint Assessment" is expected to incorporate more up-to-date information about the impacts of climate change,[49] it remains unclear precisely how climate change impacts will change the TMDL load allocations, if at all.[50] Moreover, there are no indications the Midpoint

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[46] *Id*. at 60; *see also* Najjar, *supra* note 43, at 20-21.

[47] *See, e.g.*, 33 U.S.C. § 1341(d); *PUD No. 1 of Jefferson Co. v. Wa. Dep't of Ecology*, 511 U.S. 700 (1994) (holding that state water quality standards, including minimum stream flow requirements, should be enforced through § 401 certifications); *Anacostia Riverkeeper Inc. v. Jackson*, 798 F.Supp.2d 210, 238 (D.D.C. 2011) (holding that a state's total maximum daily loads for a water body must ensure protection of all state water quality standards, including *all* designated uses and water quality criteria, in order to satisfy the CWA); *AES Sparrows Point LNG v. Wilson*, 589 F.3d 721, 733 (4th Cir. 2009); *Islander East Pipeline Co., LLC v. McCarthy*, 525 F.3d 141 (2d Cir. 2008); *see also supra* part I.C of these comments.

[48] EPA, Chesapeake Bay TMDL, App. E, https://www.epa.gov/sites/production/files/2015-02/documents/appendix_e_climate_change_final.pdf.

[49] EPA, Chesapeake Bay TMDL 2017 Mid-Point Assessment: Guiding Principles and Options for Addressing Climate Change Considerations in the Jurisdictions' Phase III Watershed Implementation Plans (Dec. 13, 2016), http://www.chesapeakebay.net/channel_files/24456/ii.f._climate_options_for_phase_iii_wips_crwg_briefing_document_12.13.16.pdf.

[50] *See, e.g.*, *Chesapeake Bay TMDL 2017 Midpoint Assessment Policy Options and Implementation Considerations for Addressing Climate Change in Jurisdictions' Phase III Watershed Implementation Plans* (Sept. 6, 2017) (noting that the relevant committee has not yet decided whether to change the TMDL's quantitative load allocations to account for the impacts of climate change), *available at*

Assessment will consider the impacts of climate change on the Conowingo Dam's specific effects. Therefore, MDE must complete its own, independent analysis of the effects climate change will have on the Conowingo Dam Project's impacts to Maryland's water quality standards.

For all the above reasons, we propose that any § 401 certification issued to support a renewed FERC license for the Conowingo Dam Project (1) include a detailed analysis of the effects of climate change, and (2) include conditions requiring Exelon to contribute financially to a specific plan for removing at least 4 million tons of sediment annually from the Conowingo reservoir, in order to offset the 1.5-2 million tons collected in the reservoir annually at the time the Chesapeake Bay TMDL modeling was performed, to eventually remove 100 million tons of material from the reservoir that would be vulnerable to scouring during the proposed license period, and to maintain that level thereafter. These conditions, at a minimum, would be necessary to avoid nutrient and sediment-related violations of state water quality standards as required by 33 U.S.C. § 1341(d).

B. Alternatively, the shortcomings in Exelon's application justify an outright denial of certification at this time.

In the alternative, should Maryland find that more information and study is required to support the certification conditions that we request and that are needed to protect water quality in Maryland's waters, the state should reject Exelon's § 401 Application due to its fatal deficiencies. As an initial matter, we note that Exelon's application mentions the Sediment Study it agreed to help fund in 2014, but it does not provide information on the results or the status of that study.[51] Given that the need for additional study was the primary reason given for delaying the licensing process, this is a serious omission. We and others in the public should not be required to comment on an application that is so patently incomplete. This section of our comments discuss additional deficiencies of Exelon's application.

1. Exelon over-relies on the Lower Susquehanna River Watershed Assessment, despite serious shortcomings.

Exelon's Application relies heavily on the Lower Susquehanna River Watershed Assessment ("LSRWA"), an inter-agency project led by the U.S. Army Corps of Engineers ("Corps") and the U.S. Geological Survey ("USGS") to assess the effects of sediment and nutrient discharges from the three dams located on the Lower Susquehanna River – Holtwood, Safe Harbor, and Conowingo.[52] As long ago as September 2014, Exelon was aware of three

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https://www.chesapeakebay.net/channel_files/25446/mpa_climate_change_policy_option_briefing_memo_wqgit_090617.pdf.

[51] § 401 Application at 2 ("…in December 2014, Exelon entered into an agreement with MDE to work with state agencies in Maryland, the U.S. Army Corps of Engineers, the U.S. Geological Survey, the University of Maryland Center for Environmental Science, and the U.S. Environmental Protection Agency to design and conduct a multi-year Sediment Study to provide additional information to MDE.")

[52] LSRWA, *supra* note 4.

significant shortcomings in the LSRWA, identified in our comments on FERC's Draft Environmental Impact Statement ("DEIS"): (1) it did not model the effects of a potential project-induced scouring event for a large-magnitude storm (*e.g.* 984,000 cubic feet per second ("cfs")), for which there is a reasonable chance of occurrence during the license period; (2) it did not sufficiently evaluate the effects of project-induced scouring on submerged aquatic vegetation ("SAV") and; (3) it did not adequately evaluate the effect of additional nutrient loading caused by project-induced scouring.[53]

In addition, today we submit with these comments our independent third-party review of the LSRWA ("LSRWA Review").[54] As discussed separately in Section III, below, the Review confirms our prior observations that the LSRWA modeling effort was undermined by unjustified and questionable assumptions, as well as important omissions, which caused the LSRWA modelers to underestimate potentially catastrophic effects of project-induced scouring on nutrient and sediment discharges to the Chesapeake Bay.

Exelon relies heavily on both the LSRWA and FERC's DEIS as support for its claim that the adverse water quality effects of the ongoing operation of the Conowingo Dam facility need not be offset by conditions in Maryland's § 401 certification, yet Exelon failed to address or overcome any of the errors or omissions in the LSRWA and DEIS. For this reason alone, Maryland is justified in denying the certification.

2. Exelon's application for a § 401 certification over-relies on the Chesapeake Bay TMDL, yet it badly mischaracterizes the analyses, assumptions, and requirements of the Chesapeake Bay TMDL.

Exelon's application mischaracterizes the *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment* (Dec. 29, 2010) ("Chesapeake Bay TMDL"), incorrectly claiming that it provides a "comprehensive framework" for addressing "any impacts resulting from the reduction in trapping capacity behind Conowingo Dam caused by sediment introduced upstream of Conowingo Dam." [55] This assertion can be readily dismissed, given that the U.S. Environmental Protection Agency ("EPA") expressly <u>declined</u> to include a wasteload allocation in the Chesapeake Bay TMDL to account for scoured-sediment and nutrient discharges from the Conowingo Dam Project.[56] This decision was based on the incorrect assumption that the Conowingo reservoir had not yet reached dynamic equilibrium (the point "after which the

[53] Comments of Stewards of the Lower Susquehanna, the Lower Susquehanna Riverkeeper, and Waterkeepers Chesapeake on Draft Multi-Project Environmental Impact Statement for Hydropower Licenses: Susquehanna Hydroelectric Projects (FERC Project No. 405-106, Sept. 29, 2014), Accession No. 20140929-5322.

[54] Paul Frank, P.E., FlowWest, Lower Susquehanna River Watershed Assessment Review (August 25, 2017), enclosed as Attachment A.

[55] Exelon Application at 3.

[56] Chesapeake Bay TMDL, Appx. T at T-2, T-5.

amount of sediment flowing into the reservoir equals the amount leaving the reservoir, and the stored volume of sediment is relatively static") and would not until after 2025.[57]

Exelon further incorrectly claims that EPA "recognized that sediment-related pollution impacts… need to be addressed directly without reliance on Conowingo Dam."[58] EPA said no such thing. It simply assumed that the Conowingo reservoir would have "trapping capacity" through 2025, and promised to revisit Pennsylvania's, Maryland's, and New York's "2-year milestones" under the TMDL if that assumption proved to be incorrect.[59]

In any event, Exelon's Application contains no evidence that reductions to ongoing pollution discharges into the Conowingo Dam reservoir from elsewhere in the watershed are capable of preventing, much less offsetting, discharges of scoured sediments and nutrients that are already concentrated in the reservoir due to the presence of the facility since 1928, and that are already liable to be discharged during flow events that exceed the scouring threshold. As long ago as 2012, the USGS noted an observed rise in the flux of total phosphorus at Conowingo, supporting the "hypothesis that this rise is caused by the filling of the reservoir, resulting in a decrease in deposition at moderate flows and a decrease in the threshold of flow required to cause scour of the reservoir sediments."[60] Whereas previous estimates had placed the scour threshold for Conowingo Pond at around 400,000 cfs, the 2012 USGS study supported an updated estimate of 175,000–300,000 cfs.[61] Based on historic flows, we can expect to see the scour threshold exceeded many times during the proposed license period.

III. MARYLAND CANNOT RELY ON THE LSRWA BECAUSE OF ITS SERIOUS SHORTCOMINGS

The LSRWA used a "daisy chain" of models to produce estimates and make predictions about future conditions related to the Conowingo Dam Project's sediment discharges, with output from one model fed into the next model in the series.[62] At each stage, the modelers made choices that resulted in under-estimations of sediment quantities and therefore underrepresented potential sediment impacts and associated nutrient impacts on the Chesapeake Bay. As a result, Maryland cannot rely on the flawed analysis and findings of the LSRWA.

This section summarizes three particular flaws in the LSRWA: (1) the modelers did not evaluate larger-sized storms for which there is a reasonable chance of occurrence during the license period; (2) for those flow events that were modeled, the modelers used a fatally-flawed

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[57] *Id*. at T-1 to T-2.

[58] Exelon Application at 19.

[59] Chesapeake Bay TMDL, Appx. T at T-5 ("If future monitoring shows the trapping capacity of the dam is reduced, then EPA would consider adjusting the Pennsylvania, Maryland and New York 2-year milestone loads based on the new delivered loads.").

[60] Hirsch (2012) at 10.

[61] *Id*. at 12.

[62] LSRWA Review at 12.

approach that likely substantially underestimated the effects of those flows on sediment discharges; and (3) the modelers did not properly evaluate the effects of sediment and nutrients during the SAV growing season. These flaws are discussed in greater detail in the enclosed LSRWA Review.

A. The LSRWA modelers did not model a 25-year, 50-year, 75-year, or 100-year return interval flow event, which have a high to reasonable chance of occurring during the license period.

Exelon is requesting a 50-year operating license. The following table sets forth the approximate chance that a particular return interval flow event will occur during a given 50-year period, and it demonstrates there is a reasonable chance that such storm events will occur during the license period.

Return interval flow event	**Percentage chance of occurring in a given 50-yr. period**[63]
100-year	40%
75-year	49%
50-year	63%
25-year	87%
20-year	92%

The LSRWA modeled flow events representing only an approximately 20-year return interval flow event. In particular, the modelers depicted Tropical Storm Lee, an approximately 20-year return interval flow event.[64] The modelers also set out to depict a high-flow event that occurred in January 1996 (for which the peak flow represented approximately a 25-50 year return interval flow event), but because of errors discussed in section III.B below, the resulting analysis was approximately equivalent to evaluating a 20-year return interval flow event, similar to Tropical Storm Lee.

The decision not to model and study the effects of a larger return interval flow event was a serious omission in the LSRWA. Because the relationship between sediment concentration and flow is exponential (as detailed below), a 50-year, 75-year or 100-year return interval flow event would have produced sediment scouring effects substantially greater than storms modeled by the LSRWA modelers. Since such storms are likely to occur during the license period, Maryland lacks the sort of analysis that would be necessary to estimate the project-induced effects that must be offset by conditions in the § 401 certification.

[63] National Oceanic and Atmospheric Administration, National Weather Service, Flood Return Period Calculator, https://www.weather.gov/epz/wxcalc_floodperiod. *See also* LSRWA Review at 8.

[64] *Id*. at 2, 5-7.

B. The LSRWA modelers underestimated the effects of the flow events they modeled by using *averages* to represent peak flow conditions and associated sediment concentrations.

Both the USGS and the Corps' models represented "peak" Tropical Storm Lee conditions based on *daily average flow* rather than using other methods of calculating peak conditions, a choice that caused the LSRWA to underrepresent the storm's effects.[65] In particular, while the highest daily average flow recorded during Tropical Storm Lee was 709,000 cfs, the highest *24-hour running average flow* was 746,000 cfs, and the highest *instantaneous flow* was 778,000 cfs. Similarly, for one part of their analysis the Corps modelers represented Tropical Storm Lee by its *storm average flow*, which was just 632,000 cfs. These choices likely explain why the models predicted sediment quantities that were lower than the best available estimates or actual measured data suggested.[66]

While the modelers at least recognized that their model outputs constituted underestimations, they chose to respond by increasing the assumed inflow load by 10%.[67] As discussed in more detail in the LSRWA Review, simply increasing the modeled loads by a mere 10% was unjustified and likely did little to improve the validity of the modeling.[68]

The LSRWA analysis also involved modeling of the January 1996 high-flow event, but the modelers represented that storm based on daily average flows rather than instantaneous flows.[69] While use of the *daily average* measure meant that the modelers considered the January 1996 flow event as having a peak of 622,000 cfs, the *instantaneous flows* (measured in 15-minute increments) peaked at 909,000 cfs.[70] As a result, the modeling for the January 1996 event represented something closer to a 20-year return interval flow event, similar to Tropical Storm Lee and significantly smaller than the high-flow events reasonably likely to occur during the requested license period.

The consequences of these choices were substantial because the relationship between flow and transport of sediment is an exponential, not linear, relationship.[71] Had the LSRWA modelers represented these storms using a more appropriate measure of peak flows, because of the exponential relationship they would certainly have predicted much greater sediment and nutrient effects. Instead, the LSRWA models presented an unjustified rosy picture of the likely effects of future high-flow events.

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[65] *Id*. at 1-2.

[66] *Id*. at 2-6, 12.

[67] *Id*. at 4.

[68] *Id*. at 4-5.

[69] *Id*. at 7.

[70] *Id*.

[71] *Id*. at 6 (citing Scott and Sharp, USGS, Sediment Transport Characteristics of Conowingo Reservoir at 19, fig.6 (Feb. 2014)).

C. The LSRWA modelers did not properly evaluate the effects of a large flow event on the SAV growing season.

The LSRWA modeling considered the effects of sediment discharges to the Chesapeake Bay during the months of January, June, and October. The modelers made this choice despite the fact that the 1967-2013 historic flow record shows there were more days at or above the scouring threshold during March, April, and May than all other remaining months.[72] As a result, the SAV growing season was largely excluded from the analysis.

CONCLUSION

As the foregoing discussion and attached supporting information demonstrates, Exelon's Application for a § 401 water quality certification cannot be issued unless Maryland imposes a requirement for the company to participate as a financial partner in a specific plan for removing a minimum of 4 million tons of sediment from Conowingo reservoir annually until 100 million tons are removed, and for maintaining the same level thereafter. If Maryland concludes that it lacks sufficient information at this time – a conclusion that is well justified given the shortcomings of the analyses discussed in this letter – Maryland should deny the certification outright. In either case, Maryland must preliminarily complete a detailed analysis of the effects of climate change in order to accurately assess the impacts the Project will have on the state's water quality standards.

We request an opportunity to meet with you and your staff to discuss these comments. If there are any questions or you would like to set a time to meet, please contact Jennifer Chavez at jchavez@earthjustice.org or by phone at 202-667-4500, ext. 5208.

Sincerely,

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[72] *Id*. at 9-10.

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Enclosure

Attachment A

LSRWA Modeling Review Final Report

PREPARED FOR:	Earthjustice and Lower Susquehanna Riverkeeper
PREPARED BY:	Paul Frank, P.E.
DATE:	**August 25, 2017**

Introduction and Purpose

FlowWest has reviewed the modeling analyses performed for the Lower Susquehanna River Watershed Assessment (LSRWA) to determine if the general conclusions presented in the LSRWA were supported by the underlying modeling analyses, to ensure that the appropriate input data and assumptions were used, and to offer professional opinions on additional or revised modeling analyses that should have been performed. We have reviewed the LSRWA Draft Report and its associated modeling appendices (MD and PA 2014, Scott and Sharp 2014, Langland and Koerkle 2014, Cerco and Noel 2014) and consulted with the Lower Susquehanna Riverkeeper regarding concerns about the inputs and assumptions for the various modeling analyses. This report documents our findings and conclusions.

LSRWA Overview

The modeling approach of the LSRWA can be summarized as follows: 1) a 1D HEC-RAS model was used to simulate hydraulic flow and sediment transport through LSR and its three reservoirs, 2) sediment loading predicted by the HEC-RAS model was used as input to a 2D AdH model that simulated hydraulic flow and sediment transport in and out of Conowingo Reservoir, and 3) sediment outflow from Conowingo Reservoir predicted by the AdH model and sediment and nutrient loads from the Chesapeake watershed were used to simulate water quality in Chesapeake Bay with the CBEMP suite of models. In some cases, with the AdH model, and with the CBMEP models, the modeling studies evaluated the relative differences in sediment loading and water quality amongst a range of current and future management scenarios.

During the course of our review we discovered several issues with the available models or omissions that led to important underestimations of potential impacts. We summarize these for each modeling effort below and then discuss the importance and treatment of sediment loads in the greater context of the LSRWA.

Peak Storm Flowrates

During our review of the LSRWA documents, we found that storms were characterized by peak flowrate, but in two different ways, leading to some confusion. Tropical Storm Lee, for example, was modeled by both the USGS with HEC-RAS and the USACE with AdH, based on ***daily average*** flow. For Tropical Storm

Lee, the highest daily average flow occurred between 12:00 am on September 8, 2011 and 12:00 am on September 9, 2011, and was 709,000 cubic feet per second (cfs).

While this daily average flow represents the 24-hour period that symmetrically spans the time 00:00 on any given day, a ***24-hour running average flow*** can be calculated at any other similarly arbitrary window, such as the window that produces the highest peak 24-hour averaged flow. For Tropical Storm Lee, this occurs by averaging instantaneous flows between 15:30 and 15:30 each day of the event, resulting in a peak 24-hour average flow of 746,000 cfs.

When the USACE AdH modelers compared their results against USGS measurements of sediment loads[1] (shown in Figure 2), Tropical Storm Lee is represented based on ***storm average flow***, or 632,000 cfs.

Based on ***instantaneous flow***, Tropical Storm Lee peaked at 778,000 cfs at 04:15 on September 9, 2011. All four methods of characterizing the flow during Tropical Storm Lee are illustrated in Figure 1. The method by which the "peak" flow is calculated has important implications for how corresponding sediment and nutrient loads to the Chesapeake Bay during storm events were modeled in the LSRWA. These implications are discussed in more detail in the sections that follow.

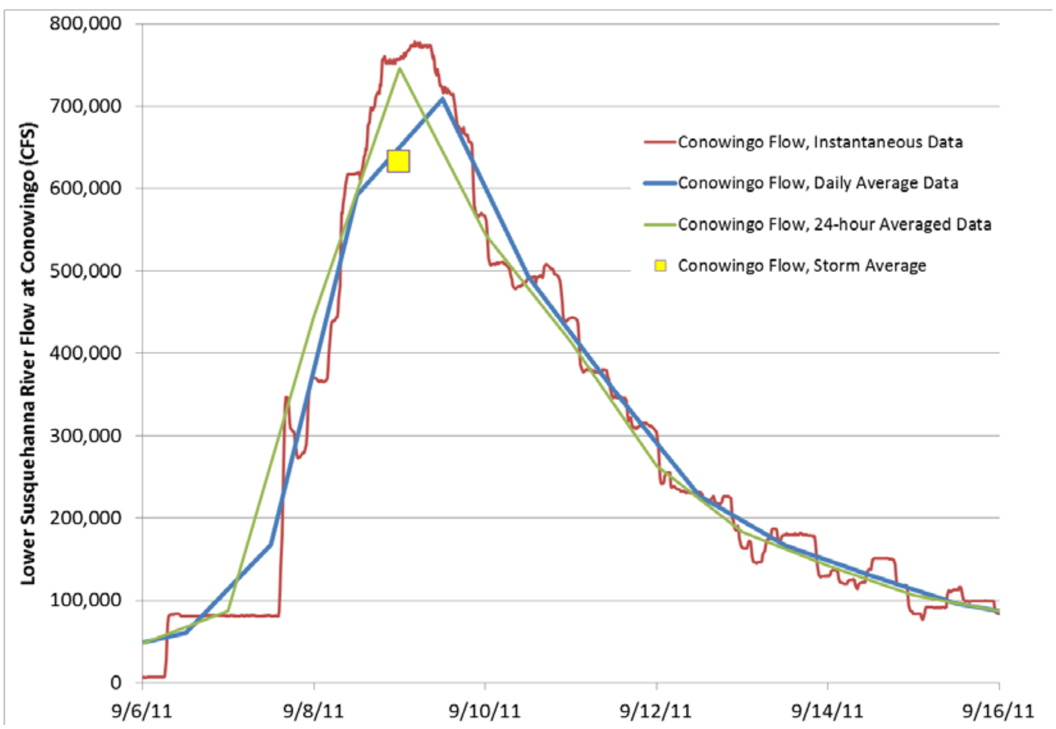

FIGURE 1: COMPARISON OF CONOWINGO FLOW BASED ON INSTANTANEOUS RECORD, DAILY AVERAGE FLOW RECORD, A 24-HOUR RUNNING AVERAGE, AND STORM AVERAGED FLOW

HEC-RAS Model Review

The USGS used a 1D HEC-RAS model to determine hydraulics and sediment transport in the three Lower Susquehanna River reservoirs and to output estimated sediment loads to Conowingo Reservoir for use

[1] Scott and Sharp 2014, pg. 30, Figure 16.

as boundary conditions to a more sophisticated 2D AdH model built by the USACE. The reported outcome of HEC-RAS modeling was that the results were not generally reliable and it was only used to generate sediment loading inputs to the AdH model. This should have been expected given the limitations of the model software, the lack of input data, and the complexity of the system being modeled. We discovered the following specific issues or limitations:

- The modelers describe in section 4.1.1 Discharge[2], that they obtained "Continuous (recorded every 15 minutes) and daily-mean streamflow (discharge) data for the Susquehanna River at Marietta, Pennsylvania (USGS 01576000) and the Susquehanna River at Conowingo, Maryland (USGS 01578310) streamgages…from the USGS National Water Information System." However, in that same section, in Figure 5[3], they show the ***daily average*** streamflow record from the Conowingo gage, which was likely used as their input flow data – the same as used by the USACE in the AdH modeling (detailed later in this document). Use of daily average streamflow as input rather than instantaneous data under-predicts potential reservoir scour due to the lower discharges considered and the exponential relationship[4] between discharge and suspended sediment concentration.

- In some locations within the model domain, when the modelers increased the input parameter of the sediment's critical shear stress, which should have reduced predicted scour, the model predicted increased scour. Such a result[5] calls the analysis and/or model into question. The "critical shear stress" parameter in a sediment transport model is an input value related to the type of sediment that makes up the channel or reservoir bottom. These values typically come from literature, and are specific to a size and type of sediment (e.g., boulders would have a different critical shear stress value than gravels, and cohesive clays would have a different value than loose sands). For a given location, the sediment transport model compares predicted hydraulic forces on the bed of the channel (shear stresses) against the critical ("threshold of erosion") shear stress of sediment in that location and if the predicted hydraulic forces exceed the critical shear stress, the model would predict erosion. If predicted hydraulic forces are lower than the critical shear stress, no erosion would be predicted. Therefore, if the modelers *increased* the critical shear value, this should have had the effect of making the channel bed more difficult to erode; however, the opposite effect occurred in some cases. Such a result calls into question the reliability of the model, and the accuracy of its predictions of sediment loads entering Conowingo Reservoir which were in turn used as input to the AdH model.

- In the summary of the HEC-RAS report the authors state[6] that "the boundary-condition data from the 1-D model were helpful in the calibration of the USACE 2-D model" – however, the AdH USACE 2-D model was never calibrated[7] (only validated). Calibration of a model involves:

    1. Calibration data collection: measuring hydraulic (e.g. water surface elevations) and sediment transport (e.g. suspended / bedload transport rates and/or changes in bed elevations) parameters in the river system during (a) particular period(s)

[2] Langland and Koerkle 2014, pg. 9.
[3] Langland and Koerkle 2014, pg. 10.
[4] Langland and Koerkle 2014, pg. 17.
[5] Langland and Koerkle 2014, pg. 23.
[6] Langland and Koerkle 2014, pg. 30.
[7] Scott and Sharp 2014, pg. 22.

2. Calibration runs: simulating that period or those periods with the model
3. Calibrating the model: tuning input parameters until the model predicts the same hydraulic and sediment transport parameters as were measured.

In general, this is very difficult and sometimes impossible for sediment transport models because of the financial and technical constraints involved in calibration data collection.

Given the uncertainties in the HEC-RAS modeling it is not clear how the boundary condition data from the 1-D model was "useful in calibrating the USACE 2-D model" (especially since the USACE 2-D model was not calibrated), or whether the boundary condition data are trustworthy given the limitations[8] of the modeling. The HEC-RAS modeling performed by the USGS resulted in predicted scour loads carried forward into the USACE AdH modeling of Conowingo Reservoir significantly lower than other estimates[9] for Tropical Storm Lee.

AdH Model Review

The 2d AdH model analysis performed detailed hydrodynamics and sediment transport within and out of Conowingo Reservoir. The analysis also evaluated response of Conowingo to various sediment management actions. A key driver of the AdH modeling was the input sediment loading condition taken from the HEC-RAS modeling by USGS. The AdH report states[10]:

"The HECRAS simulations produced two sediment inflow scenarios. The first scenario indicated no scour from the upper two reservoirs. The total inflow into Conowingo for this scenario was approximately 22.0 million tons [*note: the actual value reported by USGS*[9] *was 22.1 million tons*]. The second scenario was for approximately 1.8 million tons of scour from the upper two reservoirs [*note: this value appears to actually be 2.1 million tons as reported in the USGS report*[9]], for a total Conowingo inflow load of approximately 24 million tons [*note: the actual value reported by USGS*[9] *was 24.4 million tons*]. For the AdH model runs, the maximum scour load from the upper two reservoirs is needed because the maximum load may influence transport capacity in Conowingo, and thus impact bed scour potential. Therefore the 24 million ton HECRAS load was increased by 10 percent to reflect a potential maximum scour load from the upper reservoirs."

The inaccurate reporting of USGS HEC-RAS results by the USACE makes it somewhat difficult to trace the usage of HEC-RAS output in the AdH model. Nevertheless, the determination of the 10% factor for additional load to reflect maximum scour was not justified. Per the USGS HEC-RAS report[11], discharges in the four-year simulation period for HEC-RAS modeling (2008-2011) reflected "normal to less than normal flows for the first 3 years." In the fourth year (classified as "above normal[11]" in terms of discharge), there were only four days "exceeding 400,000 cfs, the estimated average bed scour threshold. The average return interval for flows of 400,000 cfs is every 5 years." Therefore, in the context of a 40 to 50-year FERC relicensing process, simply increasing scour loads by only 10% from a generally below-normal period with only four days out of four years of discharge exceeding the scour

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[8] Langland and Koerkle 2014, pg. 22.
[9] Langland and Koerkle 2014, pg. 26, Table 6.
[10] Scott and Sharp 2014, pg. 16.
[11] Langland and Koerkle 2014, pg. 9.

threshold was not an appropriate method for estimating “maximum potential scour” from the two upstream reservoirs. Given that the HEC-RAS modeling was found to consistently under-predict reservoir scour, even a 10% increase in HEC-RAS model output does not effectively represent a “maximum” scour condition, especially considering that the four-year period modeled included three below-normal flow years and Tropical Storm Lee represented an approximately 20-year return interval event. For the 40-50-year planning horizon, the “maximum” scour condition feeding Conowingo Reservoir would undoubtedly be substantially higher, and the AdH modeling effort should have recognized this and performed additional simulations with substantially higher sediment loading conditions.

The USACE AdH modelers compared the output of their model for the Tropical Storm Lee event against a USGS curve relating magnitude of storm event (in terms of daily average flow) to total scour load, the results of which are shown below in Figure 2.

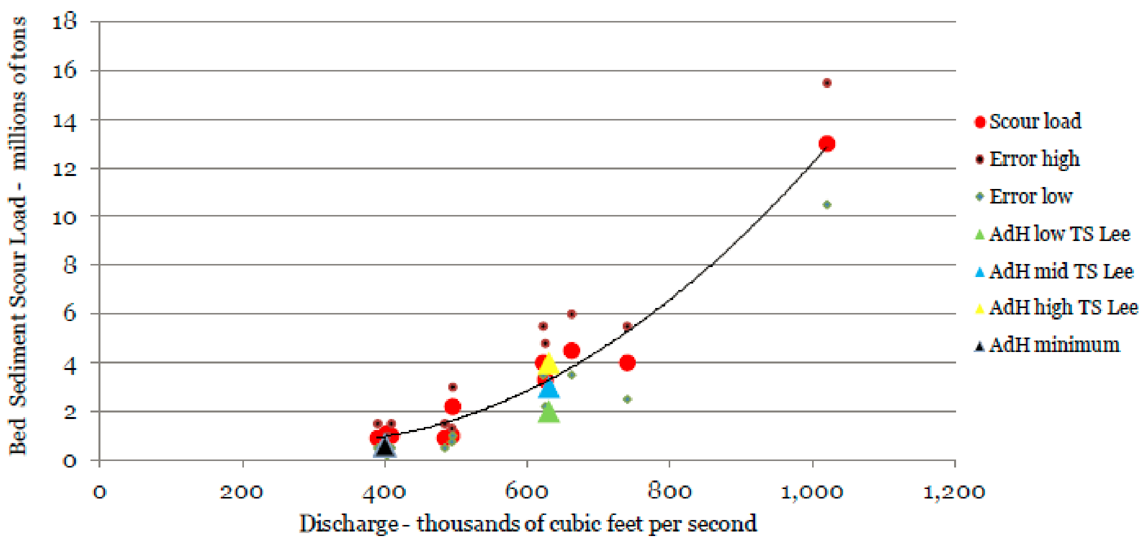

FIGURE 2: COMPARISON OF ADH RESULTS FOR TROPICAL STORM LEE AGAINST USGS SCOUR CURVE

The AdH modeling effort simulated Tropical Storm Lee under “low, mid, and high” model settings, which resulted in estimates of total scour of 2 million, 2.9 million, and 4 million tons, respectively (Figure 2). Yet as shown in Figure 2, when compared against the USGS scour estimates, which also are presented as range of values for each storm event, the AdH results are lower than the USGS estimates for Tropical Storm Lee and lower than the regression curve. While actual values were not reported by USACE for the USGS curve, from visual inspection it appears that for Tropical Storm Lee, the low, mid, and high USGS estimates are approximately 2.1 million, 3.5 million, and 5 million tons (Figure 2). These represent potential under-predictions of Tropical Storm Lee scour of 5%, 17%, and 20%, respectively by the AdH model.

One potential cause for the under-prediction of scour from Tropical Storm Lee was the decision of the AdH modelers to use daily average flow as their model input rather than the available instantaneous flow data from the USGS stream gage at Conowingo[12]. Figure 3 below shows a comparison of the four-year LSR streamflow record at Conowingo represented as a daily average flow (blue, as used by AdH modelers) and as instantaneous (i.e., on a 15-minute interval[13], shown as red).

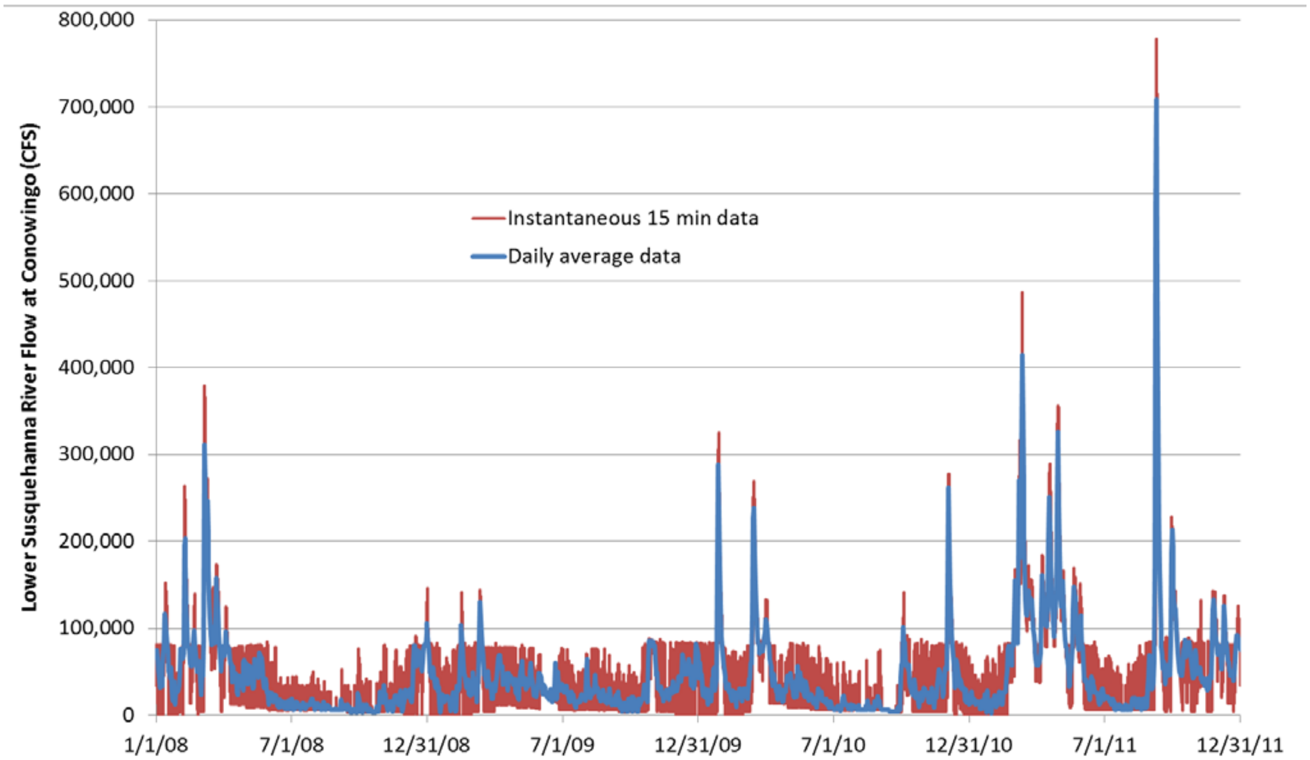

FIGURE 3: COMPARISON OF DAIL AVERAGE VS INSTANTANEOUS FLOW RECORDS FOR LSR AT CONOWINGO

It is clear from Figure 3 that USACE's use of the daily average flow record rather than the instantaneous record resulted in substantially lower peak flows during storm events in the 2008 to 2011 modeling time frame. During that four-year period, there were two events above the 400,000 cfs scour threshold and eight additional events between 200,000 and 400,000 cfs, where scour of finer sediments is known to begin[14]. Because the relationship between flow and transport of sediment is an exponential relationship, the AdH modeling would have predicted a higher four-year sediment load and a higher Tropical Storm Lee load to the Chesapeake Bay had the analysis used the instantaneous data as its input flow, potentially resulting in a better match against the USGS regression equation (Figure 2) for Tropical Storm Lee. The AdH model's estimate of sediment load out of Conowingo from Tropical Storm Lee was directly used in the CBEMP model to represent storm scour, and therefore this under-prediction represents a key factor in the degree to which representative conditions of scour were evaluated in the LSRWA.

[12] Scott and Sharp 2014, pg. 15.
[13] USGS Gage 01578310 SUSQUEHANNA RIVER AT CONOWINGO, MD; http://waterdata.usgs.gov/usa/nwis/uv?01578310.
[14] Scott and Sharp 2014, pg. 36.

CBEMP Models Review

The CBEMP included the WSM and the WQM models. The WSM simulated the whole Chesapeake Bay watershed to estimate loads of sediment and nutrients to the Bay. The WQM simulates water quality in the Chesapeake Bay itself. These two models were coupled in an analysis spanning 1991 to 2000 with adjustments made to apply scour results from the 2008-2011 AdH output for Tropical Storm Lee to the 1991-2000 period. We discovered the following issues during our review:

- The CBEMP modeling considered only daily average flows on the LSR, rather than instantaneous (i.e., 15-minute data) flows. This meant that the January 1996 storm, which peaked at 909,000 cfs, was considered to have been a 622,000 cfs event. A modeling approach considering the higher flows from instantaneous data would have produced greater sediment loads to the Chesapeake Bay, which would likely have resulted in greater nutrient-related impacts.

- WSM sediment results at Conowingo for the January 1996 event showed little to no scour which did not agree with observed data[15]; modelers performed an "erosion adjustment" to improve the results. It is not clear exactly what was done to make this adjustment, although we assume from the report that the CBEMP modelers added the predicted scour from the Tropical Storm Lee simulation from the AdH model on top of watershed sediment loads predicted by the WSM model. We further assume, although it is not documented, that the CBEMP modelers added the "mid TS Lee" predicted scour from AdH (Figure 2).

  Given 1) the inability of the USGS HEC-RAS model (which provided the sediment loading input to the AdH model) to accurately estimate reservoir scour, 2) the USACE AdH model's use of a low input sediment loading condition not representative of maximum probable sediment loads during the 40-50-year planning horizon, and 3) the low prediction of Tropical Storm Lee scour by the AdH model relative to USGS estimations (Figure 2), it is unlikely that the CBEMP model evaluated the effects of a representative storm scour condition on the Chesapeake Bay.

- The AdH modeling, which spanned the years 2008-2011, included Tropical Storm Lee, an approximately 20-year return interval flow event. The CBEMP modeling, which spanned the years 1991-2000, included the January 1996 storm event whose peak flow represented 25-50-year return interval flow event. However, since only daily average flows were considered, rather than peak flows (as described above this reduced the event from a 909,000 cfs event to a 622,000 cfs event), it represents an approximately 20-year return interval flow event similar to Tropical Storm Lee.

  It is notable that the WSM predicted little to no scour from Conowingo during the January 1996 event, requiring the modelers to add scour contributions from Conowingo from the AdH modeling of Tropical Storm Lee to the WSM to bring it into agreement with observations. Given that the FERC licensing process for Conowingo is likely to be more than 40 years, the effects of larger storm scouring events on the Chesapeake Bay should have been performed. In a given 40-year period, there is an approximately 33%

[15] Cerco and Noel 2014, pg. 24.

chance that a 100-year return interval flow event will occur, meaning that there is a reasonable chance in the next FERC license period for Conowingo that a bed scour event substantially larger than either the Tropical Storm Lee or January 1996 event will occur. Because the AdH modeling produced lower scour predictions from Conowingo than estimated by USGS (Figure 2), the CBEMP evaluations carried these low scour predictions forward to the impacts analysis which underestimated storm-based scour loads on the Chesapeake Bay.

- In Figure 4-2 of the CBEMP modeling report[16] (shown below as Figure 4), the authors present an illustration of how addition of predicted sediment scour from the AdH modeling was added to the CBEMP model to bring predictions of suspended sediment concentration in line with observations from the January 1996 storm event.

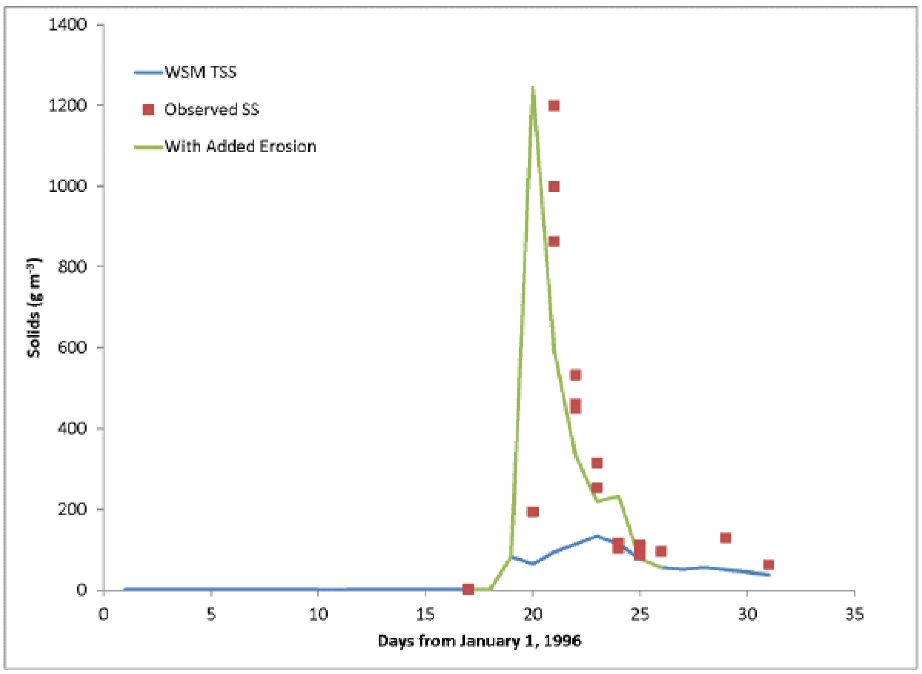

FIGURE 4: OBSERVED AND COMPUTED SUSPENDED SOLIDS AT THE CONOWINGO OUTFALL, JANUARY 1996. COMPUTATIONS ARE SHOWN FOR THE WSM AND FOR THE WSM WITH ADDITIONAL EROSION LOAD.

While the comparison seems to indicate a very close agreement between the shape of the sediment data for the January 1996 event and the "peak" sediment concentration of the event, this is not true. The highest observed value for sediment concentration was 1200 g/m^3, which was recorded on January 21, 1996 at 13:15. This sample was collected almost ***20 hours after the peak of the storm, which was on January 20, 1996 at 17:00***. The collected sample coincided with a flow of 623,000 cfs, approximately 31% lower than the peak of 909,000 cfs. Furthermore, this "peak" sample was collected on the receding limb of the event, further illustrated by the fact that the green model line is offset backwards in time from the red point of the sample in Figure 4. Because of the fact that 1) the relationship between suspended sediment concentration and flow is

[16] Cerco and Noel 2014, pg. 33.

exponential and 2) as reported by Scott and Sharp[17], "the highest suspended sediment concentrations are found on the ascending leg of the hydrograph, whereas the descending leg typically has lower values," then had the erosion-adjusted model been accurately predicting suspended sediment leaving Conowingo, the green line in Figure 4 would have peaked significantly (potentially several times) higher. This is because had a sediment sample been taken at or near the peak of the January 1996 storm of 909,000 cfs (sediment samples cannot generally be taken above 600,000 cfs due to safety concerns[18]), its concentrations would have been much greater than 1,200 g/m^3, because the relationship between sediment concentration and flow is exponential.

- The CBEMP modeling analysis of impacts of sediment on Chesapeake Bay should have included an analysis of a 100-year return interval event because it has at least a 33% likelihood of occurring in the next FERC license period (40-50 years) for Conowingo, and may occur during a time when Conowingo is full of sediment, maximizing the release of sediment and potential impacts to Chesapeake Bay. Due to the exponential relationship between sediment loads and flow, such analysis would have resulted in evaluation of sediment loads several times greater than those evaluated, potentially altering the LSRWA's conclusions.

- The CBEMP modeling considered the impacts on the Chesapeake Bay in the months of January, June, and October, in an attempt to evaluate likely timing of large storm events. The spring growing season for submerged aquatic vegetation (SAV) was excluded from this analysis. Yet as reported by Langland and Koerkle[19], over the period 1967 – 2013, more days with daily mean flow at or above the erosion threshold for LSR reservoirs happened in the March through May spring season than the entire rest of the seasons combined (33 in spring vs. 31 in winter, summer, and fall) as shown in Figure 5. The analysis should therefore have included a simulation with a spring storm to evaluate potential ecosystem impacts.

[17] Scott and Sharp, 2014, pg. 24.
[18] Scott and Sharp, 2014, pg. 17.
[19] Langland and Koerkle 2014, Figure A3, pg. 38.

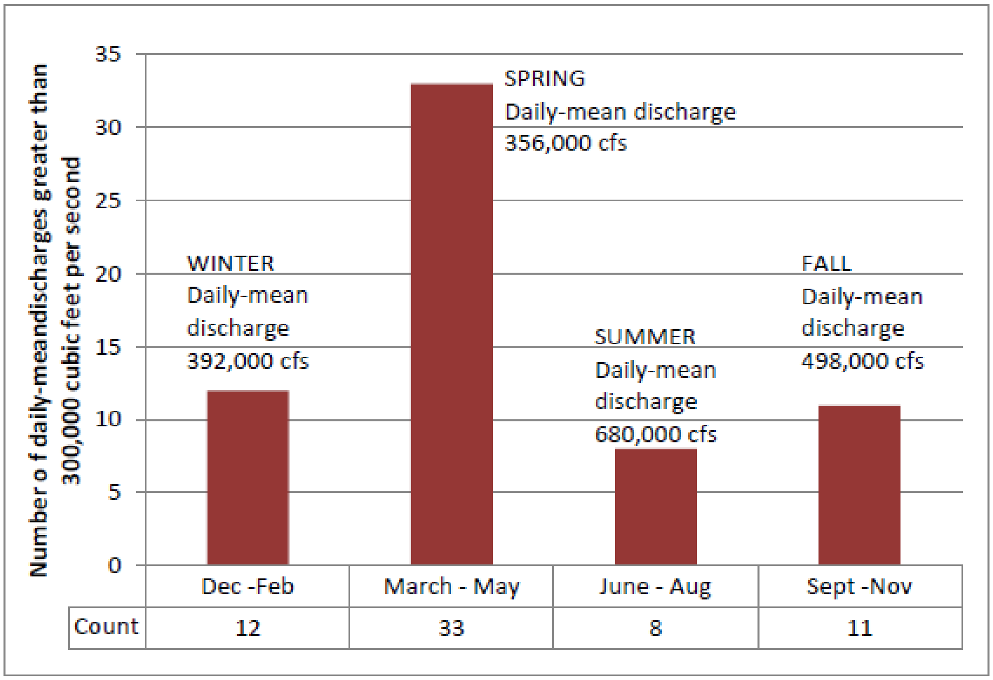

FIGURE 5: NUMBER OF DAILY-MEAN DISCHARGES GREATER THAN 300,000 CUBIC FEET PER SECOND (CFS) AND DAILY MEAN DISCHARGE BY SEASON AT SUSQUEHANNA RIVER AT CONOWINGO, MARYLAND (1967-2013).

Estimates of Annual Sediment Load to Chesapeake Bay from the Lower Susquehanna River/ Conowingo Reservoir

Concerns have been raised by the LSR Riverkeeper about the estimates of annual sediment load to the Chesapeake Bay from the LSR, and whether the modeled predictions are representative of a wide enough range of conditions. We reviewed the assumptions and methods used by various entities involved in the LSRWA to develop these. During the course of the LSRWA study, several different estimates of sediment loads from the LSR to the Chesapeake Bay were developed through modeling or bathymetry/sediment data analysis. They can be summarized as follows:

- USACE AdH Modeling: The AdH modelers from USACE used a rating curve developed from the USGS HEC-RAS model as the input sediment load to Conowingo Reservoir for their simulations. For their four-year modeling window, which included the effects of Tropical Storm Lee in 2011, the AdH modelers used the maximum predicted sediment load from upstream of Conowingo, "approximately" 22 million tons, and increased this by 10% to either 26.2 or 26.3 million tons (this value is reported differently in different parts of the report). For Conowingo sediment output to Chesapeake Bay, their results indicated a range from 20.3 million tons (1996 bathymetry) to 22.3 million tons (2011 bathymetry). Their predicted Conowingo scour loads from the bed of the reservoir ranged from 1.8 million tons (1996 bathymetry) to 3.0 million tons (2011 bathymetry).

  Therefore, the AdH model assumed ~6.6 million tons per year (26.2 million tons / 4 years) inflow to Conowingo and predicted ~5 – 5.5 million tons per year (20.3 – 22.3

million tons / 4 years) outflow to Chesapeake Bay including 0.5 – 0.8 million tons of reservoir bed scour, and 1.0 to 1.5 million tons per year of sediment trapping[20].

- CBEMP Modeling: The CBEMP modeling used its WSM component to estimate sediment loads to and out of Conowingo Reservoir. The modeling window for this work was 1991-2000, which included the effects of a large storm in 1996. This model erroneously predicted no bed scour from Conowingo, and therefore added scour results from the AdH model (modified to reflect differences between Tropical Storm Lee and the 1996 storm). Sediment loading was reported as an average per day during the modeling window. They reported daily loads out of Conowingo Reservoir of 3,056,623 kg for the 2010 progress condition (baseline) and 4,113,762 kg for the No Conowingo scenario (assuming no trapping in Conowingo and full transport of sediment from upstream of Conowingo to the Chesapeake Bay). WSM-computed loads of sediment inflowing to Conowingo were not reported.

  Therefore, the CBEMP modeling predicted ~1.2 million tons per year (converted from ~3 million kg/day) outflow to Chesapeake Bay under the baseline scenario and ~1.7 million tons per year (converted from ~4.1 million kg/day) under the No Conowingo scenario, which equals ~0.5 million tons per year of sediment trapping[21].

- USGS estimations: The USGS estimated sediment loads based on surveys and sediment data coming into and leaving Conowingo Reservoir in five time periods between 1928 and 2012. During the 1993-2012 window, which generally spans the years of modeling with AdH and CBEMP, the USGS estimated the cumulative load to all three LSR reservoirs and from LSR ultimately to Chesapeake Bay.

  The USGS estimated 3.8 million tons per year inflow to the three reservoirs and 1.8 million tons per year outflow to Chesapeake Bay, and 2.0 million tons per year of sediment trapping[22].

A comparison of modeled sediment loading vs. that estimated by USGS is presented in Table 1.

	USACE AdH Model	CBEMP Model	USGS Estimates
Conowingo Sediment Inflow	6.6	NA	NA
Sediment Outflow to Chesapeake	5.5	1.2 - 1.7	1.8
Conowingo Sediment Trapping	1.0 - 1.5	0.5	2

Table 1: Summary of annual sediment quantities. All quantities are in millions of tons per year.

The CBEMP modeling estimated average annual export of sediment to Chesapeake Bay from the LSR at a lower level than either the AdH model or the USGS estimates (1.2 – 1.7 million tons/yr vs. 1.8 – 5.5 million tons/yr). The CBEMP modeling also estimated sediment trapping by Conowingo substantially lower than other efforts (0.5 million tons/yr vs. 1.0-2.0 million tons/yr). This means that the CBEMP

[20] Scott and Sharp, 2014, pgs. 29-31.
[21] Cerco and Noel, 2014, Table 4-1, pg. 27.
[22] Langland and Koerkle, 2014, Table 6, pg. 26.

water quality modeling and biological impacts analyses likely underestimated effects of sediment loading to the Chesapeake Bay on an annual average basis, and possibly underestimates the benefits that Conowingo can provide to the Chesapeake Bay through sediment trapping.

Review Summary

Based on our review of the available documents and modeling analyses, we have concluded the following:

- The LSRWA analysis of sediment and nutrient impacts on the Chesapeake Bay depended on a “daisy chain” of models that passed outputs successively from one model to another. At each stage, predicted sediment quantities were lower than the best available estimates or actual measured data suggested, in some cases by considerable amounts. This resulted in an underrepresentation of potential sediment impacts (and in turn likely nutrient impacts) on the Chesapeake Bay.

- In general, the AdH and CBEMP modelers did not appropriately reflect the exponential relationship between flow and sediment load, and selected input model flowrates that did not reflect the expected magnitude of events likely to occur during the 40-50 year FERC licensing window.

- The AdH and CBEMP models predicted and evaluated the impacts of annual sediment loading rates to the Chesapeake Bay that were lower than estimates made from actual observations of bathymetric change and measured sediment loads by the USGS, therefore underestimating the impacts of typical annual sediment loading on the Chesapeake Bay.

- The CBEMP modeling did not adequately consider the seasonal effects of storm scour loads in the spring growing season for SAV.

References

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