Recommendations of the Expert Panel to Define Removal Rates for Shoreline Management Projects

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NOTE: THIS VERSION SUPERCEDES ALL PRIOR VERSIONS OF THIS EXPERT PANEL REPORT

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KEY CHANGES IN THE 2017 VERSION OF THE EXPERT PANEL REPORT
(FUTHER CORRECTED IN OCTOBER 2019)

This version has been amended to enhance how the shoreline management credit is applied in tidal waters of the Chesapeake Bay. Some of the key additions to this edition include:

- *A default removal rate is provided for the nutrient reduction achieved by shoreline management projects (expressed as lbs of nutrient reduced per linear foot/year. This is helpful for watershed planning purposes, and cases where the protocols have not been applied.*

- *Default nutrient enrichment factors for shoreline sediments have been adopted to estimate nutrient reduction using Protocol 1 (Prevented Sediments). The nutrient enrichment factors are based on the total estimated sediment loss including clays, silts, and sand. Total sediment is used for nutrient enrichment factors because the original weight nutrient/weight sediment percent observations were based on total sediment.*

- *The sand adjustment factor has been integrated into the description of methods to estimate shoreline sediment loss in Protocol 1 (Prevented Sediment. Only the clays and silt are counted in sediment loss to tidal waters because the sand portion of the total sediment is considered to be environmentally beneficial for benthic habitat.*

- *All references to pollutant load reduction gaps have been deleted from this edition, as the Bay and Watershed modelers now explicitly simulate shoreline erosion in the tidal waters of the Bay.*

- *The design examples in the report have been revised to reflect the additions above.*

Cheston Point, MD (top), a retreating shoreline in VA (bottom left) and Bay Tree Beach, York County in VA (bottom right). Pictures courtesy of Jana Davis and Pam Mason.

Table of Contents

Tables

Figures

Executive Summary

Tidal shorelines in the Chesapeake Bay have been erosional over the entire geological history of the Bay. Eroding shorelines are fundamental to the environmental character of Chesapeake Bay and serve to simultaneously create, maintain, and destroy a variety of shoreline and nearshore habitats. A basic challenge of shoreline management is how to balance maintaining natural shoreline processes and habitats — fundamental to the character and health of the Chesapeake Bay — with the legal right of shoreline property owners to protect their properties from erosion. Many shoreline landowners in the tidal Chesapeake Bay states protect shoreline property and water quality using a suite of shoreline management practices. These shoreline management practices consist of structural or hard practices, vegetated practices, or a mix of hardened and vegetative practices often called a hybrid approach.

Currently, states and local jurisdictions claim minimal nutrient and sediment reduction pollutant load reduction for shoreline projects as no one has systematically reviewed the available science to determine the appropriate “credit” for these practices. It is the purpose of this Panel to review the science and develop protocols to estimate the sediment and nutrient pollutant load reduction associated with different shoreline management practices. This will enable the Bay states to use shoreline management practices as part of an overall watershed strategy to meet nutrient and sediment load reduction targets for existing urban development under the Chesapeake Bay Total Maximum Daily Load (TMDL).

The Panel conducted an extensive review of recent and relevant shoreline management practice research and their effect on the processing, storage, and delivery of sediments and nutrients to the Bay. The Panel agreed that the existing credit associated with shoreline practices is not scientifically defensible because it is based on a tangentially related practice, stream restoration. Furthermore, the existing credit does not account for the uniqueness of every project with respect to its design, shoreline location/position, and function.

While the resulting panel recommendations represent the majority view, significant dissent (40 % of the panel) exists regarding several of the main findings. The dissenting view opposed the use of Protocol 1 because the protocol could incentivize practices that would reduce large grain (sand) as well as fine grain (silt and clay) sediments. In short, the dissenters cited multiple studies that demonstrate the benefits of large grain sediments to wetlands and submerged aquatic vegetation areas (SAVs). The WQGIT recognizes that improving SAV is one of the water quality goals of the TMDL and that SAV, along with wetlands, are specific natural resources targeted for restoration by the Bay Program in the 2014 Bay Agreement.

Therefore, to address this dissenting opinion, the WQGIT agreed to allow States to determine, on a case-by-case basis, when the unintended consequences of negative impacts to wetlands and SAVs caused by these shoreline management techniques, outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit. Local implementers are encouraged to review their projects with the jurisdictions prior to planning, design, and installation of the shoreline management techniques to eliminate or minimize unintended consequences.

The dissenting view is presented in Appendix L. The purpose of this dissenting view is to summarize the areas of dissent and describe its logic such that those reviewing the report, including various Bay Program committees and boards as well as the general public, can be aware of the issues. However, there was no dissention on the actual efficiency of the shoreline management practices which was the primary charge of the panel.

Importantly, the tidal shoreline best management practice (BMP) differs from other urban BMPs. The tidal shoreline load is in the Water Quality and Sediment Transport Model (also known as the Estuary Model) and the pollutant load reduction is in the Chesapeake Bay Watershed Model. The BMP is on the shoreline edge therefore the shoreline management practices stop sediment and nutrients from entering the Chesapeake Bay directly. This means that there is no sediment delivery factor. Therefore, the benefit and associated pollutant load reduction credit can be much higher than other urban BMPs. In addition, the BMP's pollutant load reduction is correlated to the tidal erosion rate. This means the higher the erosion at a site the higher the pollutant load reduction can be when a BMP is implemented.

There are ecosystem tradeoffs and future research needs that were identified. For example, the shoreline sand content is valuable to nearshore habitat such as SAV beds. Therefore, the panel incorporated recommendations to value habitat and meet Bay water quality goals. The panel recommended pollutant load reductions that were conservative based on the available science and provided recommendations to reduce unintended consequences.

The basic qualifying conditions are extremely important, and each shoreline management practice must pass all conditions prior to any Chesapeake Bay TMDL pollutant load reductions allowed. The Panel recommended qualifying conditions and environmental considerations for shoreline management projects to ensure they support both the Chesapeake Bay and local environmental goals. Also, examples are provided (*Section 5.3 Examples*) to show users how to apply each protocol in the appropriate manner.

The Panel recognized that the data available at this time fail to allow a perfect understanding or prediction of shoreline management performance. As a result, the Panel stressed that verification of the initial and long-term performance of shoreline management projects is critical to ensure that projects are functioning as designed. To this end, the Panel recommended that the shoreline management credits be limited to five years, although the credits can be renewed based on a field inspection that verifies the project still exists, is adequately maintained, and is operating as designed.

The Panel developed the following four general protocols to define the pollutant load reductions associated with individual shoreline management projects plus a default rate for non-conforming projects. In order to receive these pollutant load reductions, the practice must meet the basic qualifying conditions that are summarized in *Section 4 Basic Qualifying Conditions for*

Individual Projects. The four shoreline management protocols and default rate added by the WTWG are provided here and are summarized in Table 1.

> *Protocol 1: Prevented Sediment* - This protocol provides an annual mass sediment reduction credit for qualifying shoreline management practices that prevent tidal shoreline erosion that would otherwise be delivered to nearshore/downstream waters. The pollutant loads are reduced for sand content and bank instability (based on the state's assessment).
>
> *Protocol 2: Credit for Denitrification* - This protocol provides an annual mass nitrogen reduction credit for qualifying shoreline management practices that include vegetation.
>
> *Protocol 3: Credit for Sedimentation* - This protocol provides an annual mass sediment and phosphorus reduction credit for qualifying shoreline management practices that include vegetation.
>
> *Protocol 4: Credit for Marsh Redfield Ratio* - This protocol provides one-time nutrient reduction credit for qualifying shoreline management practices that include vegetation.
>
> *Default Rate* - This protocol provides an annual mass sediment and nutrient reduction credit for qualifying shoreline management practices, which is shown in Table 19 from Appendix C.

An individual shoreline management project may qualify for pollutant load reductions under one or more of the protocols, depending on its design and overall restoration approach. In cases when the shoreline management practice parameters are unavailable for the protocols recommended by the panel, such as in some planning efforts, historic projects, and/or nonconforming projects, the WTWG recommends that default reduction values be used. The default values are 164.0 (MD, DE and DC) and 42.0 (VA) sediment fines (clay and silt) in lbs. per foot per year and are based on the fine sediment erosion rates provided in Table 3 from Halka (2013) with an assumption that the practice is 50% effective (for Maryland practices only - MDE decided to impose a 50% reduction factor because of bank stability concerns).

Default values for TP and TN were considered after the Modeling Work Group had an opportunity to evaluate the availability/reactivity of TP and TN associated with shoreline sediments. As a result of the analysis, an average of 0.00029 lbs TN/ lb of TSS and 0. 000205 lbs TP/ lb of TSS can be used as a default for projects where Protocol 1 will be applied. The TN and TP estimates are from all the bank nutrient measurements (n=160) in Ibison et al. (1990 and 1992) and are used for all tidal shoreline nutrient loads in the 2017 Water Quality and Sediment Transport Model (WQSTM) of the Chesapeake Bay.

The pollutant load reductions are available for five years and renewable upon field verification to ensure they are still working as designed. Additional research and management needs were identified in the panel's review and are outlined in the report (*Section 7 Future Research and*

Management Needs). The panel report's recommendations should be updated every two years so that the latest science is incorporated in these management recommendations.

Table 1. Summary of shoreline management pollutant load reduction for individual projects.

Protocol	Submitted Unit	Total Nitrogen (lbs per unit)	Total Phosphorus (lbs per unit)	Total Suspended Sediment (lbs per unit)
Protocol 1 - Prevented Sediment	Linear Feet	Project-Specific*	Project-Specific*	Project-Specific
Protocol 2 – Denitrification	Acres of re-vegetation	85	NA	NA
Protocol 3 - Sedimentation	Acres of re-vegetation	NA	5.289	6,959
Protocol 4 – Marsh Redfield Ratio	Acres of re-vegetation	6.83	0.3	NA
Non-conforming/Existing Practices *	Linear Feet	MD = 0.04756 VA = 0.01218	MD = 0.03362 VA = 0.00861	MD = 164 VA = 42

*The WTWG initially recommended no reductions for TN and TP until the Modeling Workgroup had an opportunity to evaluate the availability of TN and TP in shoreline sediments in 2017. The WTWG approved the reductions following the Modeling Workgroup analysis which estimated an average of 0.00029 lbs TN/ lb of TSS and 0.000205 lbs TP/ lb of TSS in eroded tidal shoreline sediment. These values can be used directly by jurisdictions for their calculations in Protocol 1, and were adapted for non-conforming/existing practices by multiplying by the default TSS reduction for non-conforming projects by the average nutrient concentrations in sediment. Note: the MD numbers also apply to DE and DC. The default rate for sediment is based on fine sediment erosion estimates from Table 3 and a 50% reduction factor applied. The first number applies to MD, DE, and DC and the second number applies to VA.

Finally, the Panel's charge and focus was to meet the Chesapeake Bay water quality goals. Additional shoreline management practice considerations such as design, cumulative impacts, sampling protocols, and others, while important, were outside this panel's charge. The panel reached consensus to the extent possible and refinements to the recommendations were made through the panel process. The panelist dedication, work, and effort to update these shoreline management pollutant load reductions using the panel process should be commended. Therefore, the panel recommendations should be implemented.

Important Disclaimer: The Panel recognizes that shoreline management projects as defined in this report may be subject to authorization and associated requirements from federal, State, and *local agencies. The recommendations in this report are not intended to supersede any other requirements or standards mandated by other government authorities. Consequently, some shoreline management projects may conflict with other regulatory requirements and may not be suitable or authorized in certain locations.*

Section 1. Charge and Membership of the Expert Panel

1.1 Panel Members

The roster of the Expert Panel for shoreline management practices are listed in Table 2. In addition, the panel background and panel charge are summarized here.

Table 2. Shoreline management expert BMP review panelists.

Panelist	Affiliation
Jana Davis, Ph.D.	Chesapeake Bay Trust (CBT) / Habitat Goal Implementation Team (HGIT)
Kevin DuBois, PWS, PWD	City of Norfolk, VA
Jeff Halka	Maryland Geologic Survey
Scott Hardaway, P.G.	Virginia Institute of Marine Scientists (VIMS) Shoreline Studies Program
George Janek	United States Army Corps of Engineers (USACE), Norfolk District
Lee Karrh	Maryland Department of Natural Resources (MD DNR)
Eva Koch, Ph.D.	University of Maryland Center for Environmental Science (UMCES)
Lewis Linker	Environmental Protection Agency Chesapeake Bay Program Office (EPA CBPO)
Pam Mason	VIMS Center for Coastal Resource Management
Ed Morgereth, MS ISS	Biohabitats, Inc.
Daniel Proctor, P.E.	Stantec (formerly Williamsburg Environmental Group)
Kevin Smith	MD DNR
Bill Stack, P.E.	Center for Watershed Protection, Inc. and EPA CBPO
Steve Stewart/Nathan Forand	Baltimore County Department of Environmental Protection and Sustainability
Bill Wolinski, P.E.	Talbot County Department of Public Works
Sadie Drescher	Center for Watershed Protection, Inc. and EPA CBPO (coordinator)
Other Panel Support: Jeff Sweeney (CBPO), Matt Johnson (CBPO/UMD), Julie Winters (CBPO), and Hannah Martin Chesapeake Research Consortium (CRC), CBPO)	

The Shoreline Management Expert Panel (the Panel) defined shoreline management practices, their pollutant load reductions, and other work outlined by the panel charge. The initial charge of the panel was to review all of the available science on the nutrient and sediment removal performance for shoreline erosion control practices. The panel was specifically requested to:

- Evaluate how shoreline erosion control practices are simulated in the context of Chesapeake Bay Watershed Model (CBWM) version 5.3.2.

- Review available literature on the nutrient and sediment loading rates associated with shoreline erosion and the effect of shoreline erosion control practices in reducing them.
- Provide a specific definition of what constitutes a shoreline erosion control practice, describe the shoreline erosion control practices' geographic boundary, and determine the qualifying conditions under which a locality can receive a nutrient and/or sediment reduction credit.
- Evaluate whether the existing CBPO-approved removal rates for shoreline erosion control practices are suitable for qualifying projects or whether a new protocol(s) needs to be developed to define improved rates. In doing so, the Panel should consider project specific factors such as physiographic region, landscape position, stream order, and/or type of shoreline erosion control protection practices employed.
- Define the proper units that local governments will report shoreline erosion control practices to the state to incorporate into the CBWM.
- Recommend procedures to report, track and verify that shoreline erosion control practices are actually being implemented and maintained during construction and after construction.
- Critically analyze any unintended consequences associated with the nutrient and sediment removal rates and any potential for double or over-counting of the credit.

1.2 Panel Process

The Panel met twelve times for two to six hour meetings in addition to several conference calls between meetings to discuss specific topics such as protocol research and development, basic qualifying conditions, geographical extent, research considerations, etc. The meetings covered the following topics: CBPO modeling background, MD and VA shoreline management policy, case studies, panel literature review and research reports, draft panel findings, and panel discussion/work. Panel members worked in between Panel meetings using email and conference calls. The Panel followed the Water Quality Goal Implementation Team (WQGIT) (2010) protocols to reach consensus and develop the report's recommendations (WQGIT, 2012). The meeting minutes for the Expert Panel can be found in Appendix A and Appendix B documents the Panel's conformity with the BMP review protocol requirements.

A flow chart for the BMP review protocol is provided in Figure 1. In general, the expert panel process starts with a new request or new research that is routed to the appropriate GIT lead then the appropriate workgroup. The BMP is prioritized and placed on a list to be updated. When there are available resources, the expert panel reviews the BMP and develops a panel report. Then the report is reviewed and edited until accepted by the appropriate workgroups and WQGIT. Finally, the panel's recommendations are integrated into the appropriate model. The BMP is periodically reviewed and reassessed through the expert panel process. This information is from the CBPO's Chesapeake*Stat* and available online at: http://stat.chesapeakebay.net/?q=node/130&quicktabs_10=3

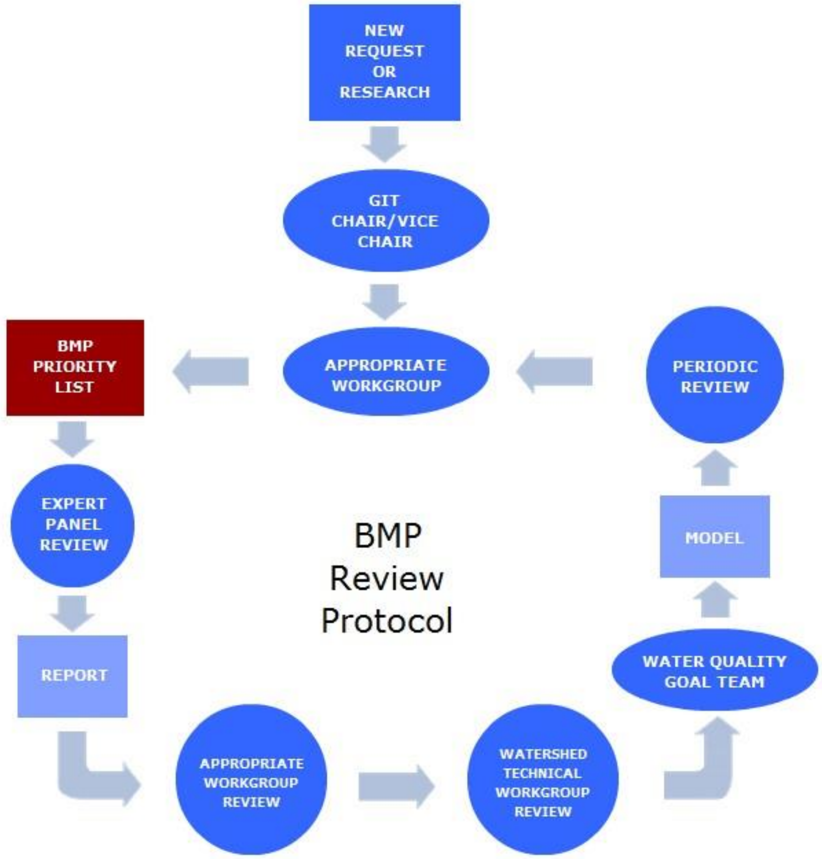

Figure 1. BMP review protocol. This information is from the *ChesapeakeStat* website and includes annotated descriptions for each process point in the decision tree.

Section 2. Definitions and Geographic Scope

This section provides shoreline management practice's past definitions, provides the current definition, and discusses the geographic scope.

2.1 Shoreline Management Definitions

There are a range of shoreline management practice types that limit tidal erosion and protect property (Figure 2). Practices that use natural habitats such as vegetation are encouraged in many states, including purely non-structural living shorelines, or hybrid living shorelines that use a combination of vegetation and hard structures. Hybrid living shorelines should aim to use as little structure as possible given site conditions to maximize the proportion of natural habitat features and decrease structure footprint. However, because design criteria have yet to be defined, debate exists about minimization of structure (Pilkey et al., 2012). Purely structural practices are often discouraged, given that a growing body of research suggests hardened shorelines negatively impact habitat value and do not increase shoreline protection functions. See also Shoreline Management and Habitat Impacts (Section 3) and Hard Shore Armor Impacts (Section 3.3.2) in this report. Both Maryland and Virginia promote vegetative shoreline erosion control through policy and guidelines. See the "Shoreline Management and Habitat Impacts" in this section for more information on practice type and habitat impact. Finally, the CBP (2006) report titled, "Best Management Practices for Sediment Control and Water Clarity Enhancement. Chesapeake Bay Program," outlined practice types and management strategies for shoreline management.

2.1.1 Current Definitions

The Scenario Builder documentation (CBP, 2012) defines shoreline erosion control practices as "protection of shoreline from excessive wave action by creating a marsh or an offshore structure such as a sill, breakwater, or sand containment structure." In Maryland and Virginia the following represent the shoreline erosion definitions:

- "Improvements to protect a person's property against erosion shall consist of nonstructural shoreline stabilization measures (i.e., living shorelines) that preserve the natural environment, such as marsh creation" HB973 – Living Shoreline Protection Act of 2008 (MDE, 2008).
- Nonstructural Shoreline Stabilization Measures or "Living shoreline" means a suite of stabilization and erosion control measures that preserve the natural shoreline and are designed to minimize shoreline erosion, maintain coastal processes, and provide aquatic habitat. Measures must include marsh plantings and may include the use of sills, sand containment structures, breakwaters, or other natural components (MDE, 2008)
- In Virginia, as per Senate Bill 964, "Living shoreline" means a shoreline management practice that provides erosion control and water quality benefits; protects, restores or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural and organic materials (VIMS, 2013).

Shoreline management practice type varies based on the site location, local regulatory requirements, and additional factors. Figure 2 outlines the shoreline management practice based on the amount of hardened armor used.

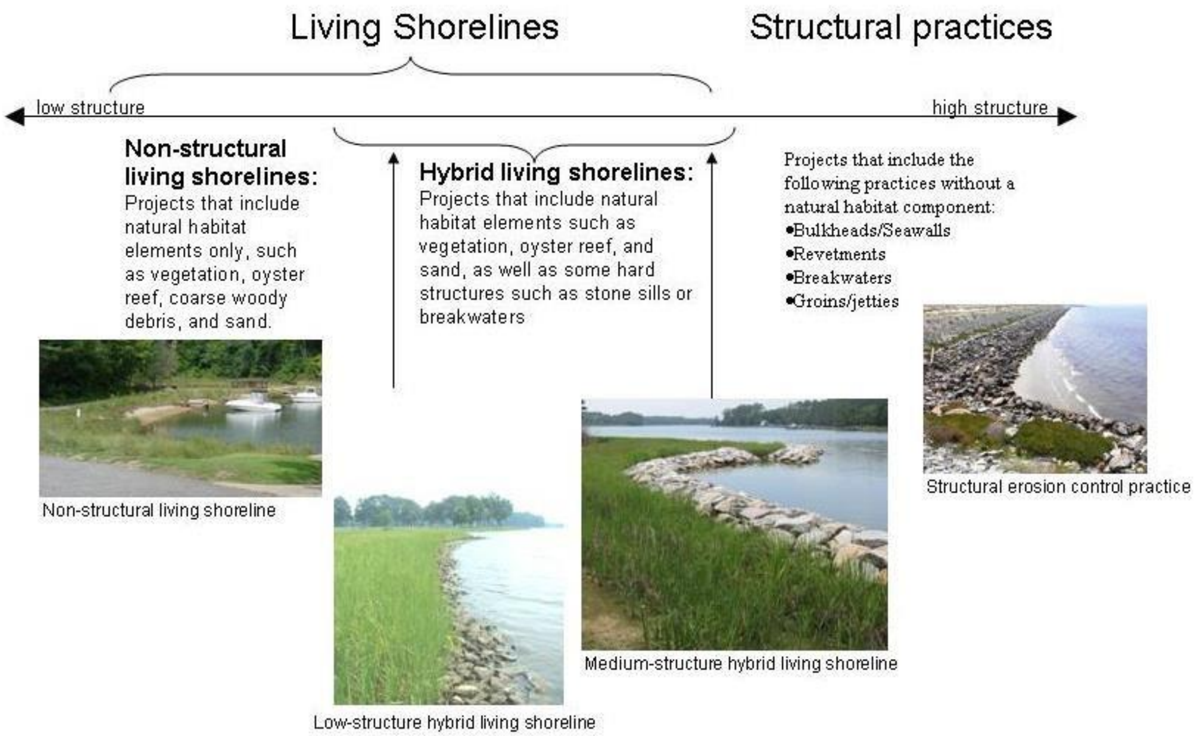

Figure 2. A continuum of shoreline management practices that is based on the amount of hard shore armor structure used.

The Panel recognized that the shoreline management practice strategy or type that is used can vary based on local policies (as well as definitions and terminology), site specific characteristics, owner preference, available funds, and other factors. In addition to the practices outlined here, the panel recognizes that innovative shoreline management strategies should be considered as part of an overall shoreline management strategy that aims to meet multiple goals (e.g., habitat, regulation, policy, and others). In consideration of the Panel's concerns as expressed by the dissenting opinion (Appendix L), the WQGIT recommends that local and state jurisdictions consider whether sediment reduction credit should be given credit toward jurisdictional Bay restoration goals in areas where SAV is already present due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

2.1.2 Expert Panel Definition

The Panel deemed "Shoreline Erosion Control" a limiting term for the practice and decided that "Shoreline Management" should be used instead. Therefore, the remainder of this report uses shoreline management for these shoreline practices. The definition for shoreline management adopted by the expert panel was the following:

- "Shoreline management" is defined as any tidal shoreline practice that prevents and/or reduces tidal sediments to the Bay.

2.2 Geographic Boundary

There is no clear geographic boundary for where tidal shoreline management practices can be implemented. The CBPO provided the panel with a map (Figure 3) that shows the tidal and non-tidal portions of the Chesapeake Bay such as lakes and reservoirs. The Panel noted that shoreline management practices could be implemented in non-tidal areas, but are most commonly implemented in tidal areas where shoreline erosion is more prevalent.

The shapefile includes segments adjacent to tidal waters and non-tidal waters where we consider there was a significant shoreline and BMPs can be implemented. This shapefile was refined by CBPO staff and is online for local municipality and/or state use at https://archive.chesapeakebay.net/Modeling/phase5/Phase532/Segmentation/p532_shoreline_v1.zip

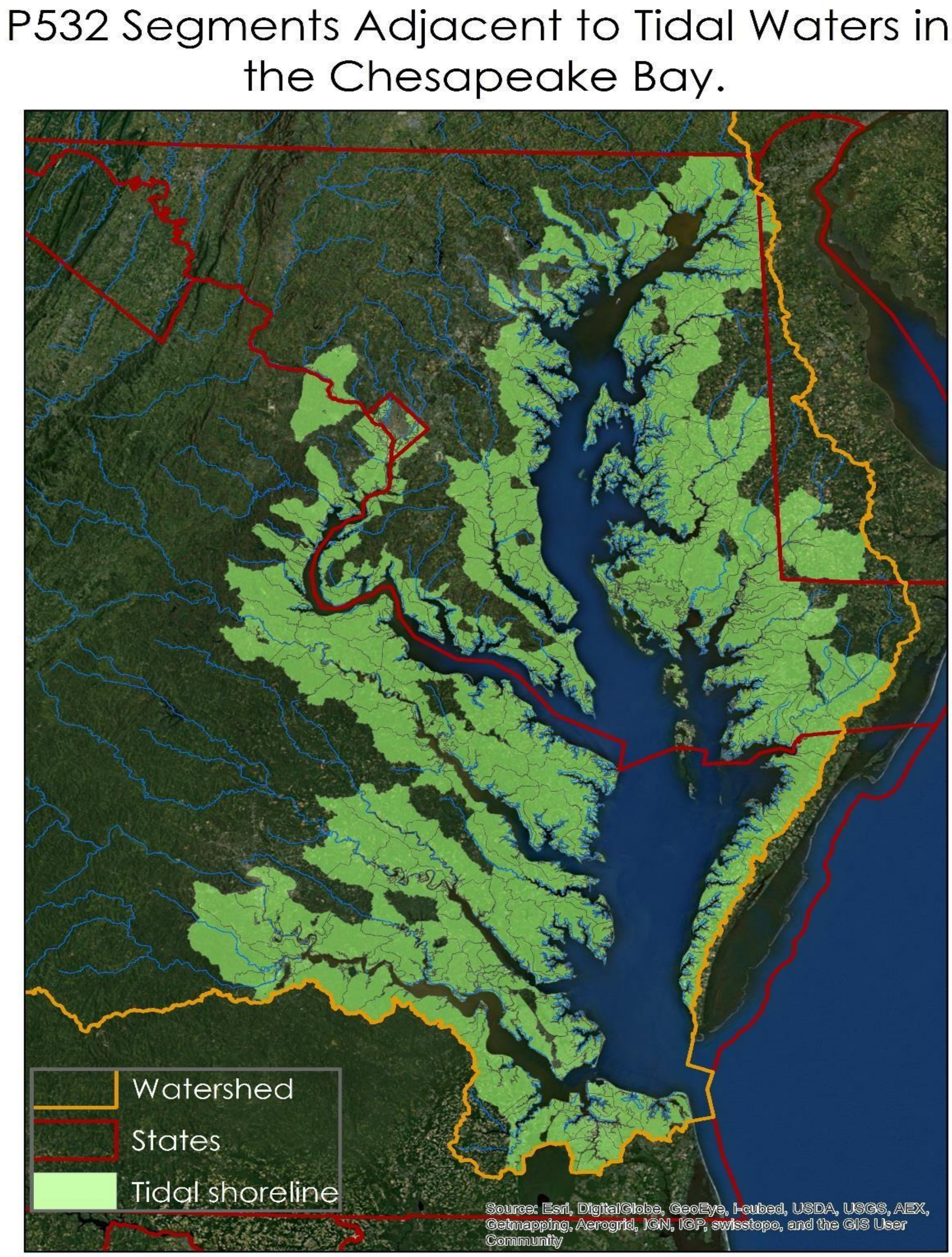

Figure 3. Segments adjacent to tidal waters in the Chesapeake Bay (shaded in the map). Map provided by CBPO Watershed Data Modeling Specialist, University of Maryland Center for Environmental Science (UMCES).

Section 3. Shore Erosion and Management in the Chesapeake Bay

The panel reviewed shoreline management policy, case studies, peer reviewed scientific and grey literature research. The panel's focus was in Maryland and Virginia since the majority of the Chesapeake Bay available for shoreline management practices are in Maryland and Virginia. However, the panel's recommendations for Maryland tidal shorelines also apply to and can be adapted for the tidal shorelines of the District of Columbia and Delaware. This section provides the panel's findings based on the review of the science for shoreline erosion, shoreline management definitions, pollutant load reduction that is currently in the Chesapeake Bay Watershed Model, shoreline management and habitat impact, and geographic boundary.

3.1 Shoreline Erosion

Coastal shoreline erosion is part of the natural ecosystem processes in the Bay and tidal tributaries and feeds the natural sediment budget that contributes to the Bay's geomorphology; however, excess suspended fine sediment degrades water quality and has adverse effects on submerged aquatic vegetation (SAV) beds and other critical habitats (Langland and Cronin, 2003). Coastal shoreline erosion is primarily caused by wind-driven waves and to a smaller extent boat wakes and is exacerbated by the rapid rate of sea-level rise (Langland and Cronin, 2003). The main factors influencing shoreline erosion are wind velocity, duration, and fetch (the open water distance wind travels) that drive wave energy climate. In addition, the soil composition (e.g., sand, silt, and clay content) of the nearshore and fastland areas and presence of vegetation are critical for determining erodibility.

Erosion of unconsolidated tidal shorelines is a major source of sediment to the Chesapeake Bay. Langland and Cronin (2003) summarizing work of the Chesapeake Bay Program's Sediment Work Group emphasized that shoreline erosion (nearshore and fastland) accounts for approximately 57% of the sediment source loads to the Bay (65% fastland and 35% nearshore). Riverine (watershed and streams) sources at the fall line account for 29% of the total load to the tidal Bay. Eroding shoreline sediments, especially large-grained sediments, contribute to geomorphologic processes such as accretion of some shorelines and maintenance of certain features such as sand spits and islands.

Eroding coastal sediments also contribute to habitat creation, by, for example, allowing for growth and accretion of tidal marshes, which may be an especially important process considering sea level rise and providing optimal conditions for SAV (Koch, 2001). However, suspended sediment in the water column, especially fine grained sediments of silts and clays, can also have negative consequences. As a result, best management practices (BMPs) were developed that address both sediment sources upland in the watershed (such as stream restoration and bank stabilization and low impact development practices) as well as sources from the shoreline itself.

Shoreline management practices prevent erosion that would enter the nearshore waters. Therefore, the nitrogen and phosphorus adhered to soil particles is also prevented from entering Bay waters. However, few studies measured the erosion rate and associated sediment TN and TP concentration. Average TN and TP concentrations reported by Ibison et al. (1990 and 1992) are the source of nutrient load estimates in the WQSTM and in this report although the individual nutrient observations in Ibison are variable both from site to site and from different elevations of any tidal shoreline site sampled by Ibison et al.

The Chesapeake Bay Program (CBP, 2005) provided early guidance on shoreline erosion management to the Tributary Teams (previous equivalent to the Watershed Implementation Plans) in a report titled "Sediment in the Chesapeake Bay and Management Issues: Tidal Erosion Processes." This report provided a broad outline of Chesapeake Bay shoreline erosion processes and introduced key aspects of coastal shoreline management that included:

1. A preference for nonstructural management in low and moderate energy shorelines;
2. Estimated shoreline erosion to be comprised of fastland erosion (57%) and nearshore erosion (43%). Note that this ratio was subsequently changed to 65% fastland erosion and 35% nearshore erosion based on expert opinions in the group (e.g., MGS, VIMS);
3. Established that shoreline erosion at some sites was environmentally benign or beneficial and that sand erosion can support fringe marsh and/or living shorelines in many areas and is a beneficial erosional resource;
4. Established that shoreline erosion of silts and clays were damaging to the Bay due to their contribution to light attenuation and bottom habitat loss and that erosion of sand was at worst environmentally neutral but often beneficial; and
5. Provided estimated watershed and shoreline erosion total suspended solids (TSS) loads by basin.

The Panel found that nearshore habitat and marsh accretion can benefit from sediment inputs such as sand in the nearshore waters. The following is a summary of the major findings from the literature related to the shoreline management loading rate and loading concentrations:

- Factors that impact loading rates include bank heights, erosion rates, and nutrient loading concentrations (Ibison et al., 1992)
- Measurements made at the site are better than estimates from literature values (Ibison et al., 1992; Langland and Cronin, 2003; Cerco et al, 2010; Proctor, 2012)
- Nutrient loads with respect to grain size and location along bank profile reported by (Ibison et al., 1990) included:
    - Higher nutrients in the upper horizons
    - No statistically significant trend in TP with grain size distribution
    - Noted relationship between TN and grain size (higher in silt/clay)
- There were differences between nutrient concentrations at the measured sites and nutrient loads varied within site at specific heights, erosion rates, and other factors. The TN ranged from 0.14 to 6.44 lbs/ft-yr and TP ranged from 0.04 to 4.42 lbs/ft-yr (Ibison et al., 1990)

- Compared shoreline component of nutrient loading to other sources was approximately 5% of the controllable NPS for TN and 23% of TP (Ibison et al., 1990)
- Explicitly stated that shoreline stabilization of critical sites was an appropriate tool to help meet Chesapeake Bay nutrient reduction goals (Ibison et al., 1990)
- Hardaway et al. (1992) assessed 383 miles of VA's eroding upland banks and estimated approximately 68,416 feet of shoreline was defended from 1985 to 1990. This 18% increase in defensive shoreline structures resulted in a sediment reduction of 403,273 cy (80,655 cy/yr). Consequently, the reduction in nutrient loading by defended shorelines was 372,924 lbs of TN and 244, 551 lbs of TP (using Ibison et al., 1990 and 1992). Finally, the annual rate reduced was 74,584 lbs/yr for TN and 48,910 lbs/yr for TP.

Table 3. Chesapeake Bay shoreline characteristics and shoreline erosion mass loading (averaged) (Halka, 2013).

Annual	MD	VA
Length (total) – (meters)	2,912,000	4,060,000
Length (unprotected) – (meters)	1,993,000	3,276,000
% Protected	32	19
Loading MT/yr - total Fines Coarse Organic	2,733,000 1,503,000 1,153,000 77,000	1,500,000 506,000 994,000 -
Loading (kg/m/day) - total Fines Coarse Organic	2.43 1.34 1.02 0.07	1.01 0.34 0.67 -
m = meters MT = metric tons		

The tidal shoreline erosion contributes sediment and nutrients to the Chesapeake Bay. Limited studies quantify the tidal shoreline erosion rate and the associated TSS, TN, and TP pollutant load to the waters. The 2010 and 2017 WQSTM (Cerco et al., 2010; 2019) provided average annual shoreline erosion mass loadings for Maryland and Virginia based on information provided by Halka (2013) and Hopkins and Halka (2006). The tidal shoreline eroded sediment loads in the WQSTM are exactly represented by Table 3.

Approximately 32% of Maryland's shores are protected and approximately 19% of Virginia's shores are protected (Table 3). The mass loading assumes that fastland protected by structures does not deliver sediment to the Bay. Cerco et al. (2010) also provides each state's fines (silt and clay), coarse (sand), and organic (delivered only from marsh erosion) sediment. The silt and clay constitute 56% of the average sediment eroded from banks and 44% of sediment eroded from marshes (Cerco et al., 2010).

3.2 Shoreline Erosion Loading Rates

Data sources to estimate tidal shore erosion loading rates and their application in the model were reviewed by the Panel. Shoreline erosion information in MD was compiled by the Maryland Geologic Survey (MGS) and in VA by the Virginia Institute of Marine Science (VIMS). The MGS monitors shoreline changes both in the Bay and along the Atlantic Coast. The MGS erosion data was compiled on the, "Shoreline Change Maps for Tidewater Maryland" maps that span from the 1800's to the 1900's. The maps are online at http://www.mgs.md.gov/coastal/maps/schangepdf.html. The MD Department of Natural Resource's Coastal Atlas' Shorelines mapping tool provides the MGS data online in a simple to use forum for the public. However, in VA there are two static reports known as the Shoreline Situation Reports (Hobbs et al., 1979; Byrne and Anderson, 1977) and the Shoreline Evolution Reports available by county. Resources for MD and VA are included in Table 4.

These are the best available shoreline erosion loading rates. However, updated information should be used when available. For example, panelist Scott Hardaway presented preliminary information from AMBUR (Hardaway, July 2013 panel meeting) which is an ongoing project to provide better bank sediment input data. This pilot study's coverage provided to the Panel included data from 1937 to 2009.

Table 4. Resources for MD and VA shoreline erosion.

MD's Coastal Atlas' Shorelines mapping tool - http://www.dnr.state.md.us/ccp/coastalatlas/shorelines.asp
VA's Shoreline Situation Reports • http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/virginia/scan_reports/SSRSummary.pdf • http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/virginia/scan_reports/TidewaterShorelineErosion.pdf

VA's Shoreline Evolution Reports
- http://web.vims.edu/physical/research/shoreline/Publications-Evolution.htm

3.3 Shoreline Management and Habitat Impacts

Tidal shoreline erosion is a natural process, albeit exacerbated by anthropogenic actions that impact a large percentage of the shoreline of the Chesapeake Bay (Berman et al., 2000). Examples of the anthropogenic actions that can exacerbate tidal shore erosion include, forest clearing of tidal shoreline, bank modification, boat wakes, and sea level rise from climate change impacts. Studies of shoreline condition by the Virginia Institute of Marine Science (VIMS) estimate that 33% of the tidal shorelines of the Chesapeake Bay are eroding, in many areas with rates up to several feet per year.

Several practices were developed to prevent or reduce erosion and protect property value and function over centuries of human shoreline development. These include seawalls, bulkheads, stone revetments, and revetments comprised of various other types of materials. In the 1970s, researchers experimented with the idea to incorporate elements of natural habitat into erosion control devices in order to improve their value and reduce the theoretical damage that hard shoreline armor causes to natural shoreline habitat function.

The technique of using naturally occurring habitats to address erosion is commonly termed "living shorelines." Living shoreline approaches initially used tidal marsh vegetation to attenuate waves instead of armor features. Within the next two decades, the concept was refined to include a variety of materials, including stone if necessary, from an engineering perspective. Incorporating natural designs was done using "hybrid" designs that incorporated both marsh, rock, and natural habitat elements such as oyster shell or reef, mussels, and coarse woody debris.

In recent years, focus has turned to quantifying living shoreline sustainability elements (e.g., how they fare at their erosion control function relative to armor in both storm conditions and general wave climates) as well as the ecological benefits (e.g., are they better habitat than armor as hypothesized.) Research suggested that both natural fringe marshes and constructed living shorelines provide habitat to greater densities and species diversity of motile macrofauna than armor (e.g., Davis et al., 2006; Seitz et al., 2006; Bilkovic and Roggero, 2008). Studies showed a preferential use of marsh edge and use of fringing marsh, such as hose typical of living shoreline design, by species including blue crab and nekton had comparable rates to extensive marshes (Currin et al., 2010).

Reasons for this preferential marsh edge use include: 1) provision of shallower depths for use as a refuge; 2) provision of structural habitat (plant stems) for use as a refuge; 3) provision of forage habitat, differences in other site characteristics such as sediment grain size which could impact prey distributions and accessibility; and 4) hybrid projects that incorporate hard structure such as rock or oyster shell as a sill or breakwater experience, enhanced use of the "blueway" between the structure, and the intertidal marsh by finfish (e.g., sea trout, red drum, flounder) and blue crabs (Swann, 2008; Scyphers et al., 2011).

As a result, management and policy strategies in many states across the United States initiated either voluntary programs (e.g., Texas, New Jersey, Rhode Island, Florida) or regulatory guidelines that are intended to promote living shorelines (e.g., Virginia, Maryland, North Carolina, and Connecticut). In addition, states implemented strategies to prevent or make extremely difficult to permit, certain types of armor, such as bulkheads (e.g., Delaware and Maryland). At the time of this report, a collaborative effort was underway in Alabama, Mississippi, Florida, Texas, and Virginia to streamline permitting processes for living shorelines.

3.3.1 Coastal Wetland and Tidal Marsh Impacts

Filling, clearing, and armoring shorelines for many different reasons have resulted in cumulative impacts to riparian areas and tidal wetlands for some time. According to the report, Status and Trends of Wetlands in the Coastal Watersheds of the Eastern United States, 1998 to 2004 (Stedman and Dahl, 2008), about 18% of all coastal wetlands losses are tidal salt marsh. In Virginia, permitted impacts to tidal wetlands from 1993 to 2004 amounted to about 42 acres (Duhring, 2004). Similarly, the current trend for riparian vegetation is toward loss of natural cover to development.

In Maryland, estuarine vegetated wetlands declined about 8% from the 1950s to late 1970s/early 1980s (Tiner and Finn, 1986). Tidal marsh loss was due to natural (submergence and sea level rise) and human (dredging and urbanization) factors. These coastal wetland losses are similar to the trends reported for the Chesapeake Bay (e.g., about 9% estuarine vegetated loss from 1950 to late 1970s/early 1980s) as reported in Tiner and Finn (1986). Past and future shoreline hardening has negatively impacted the riparian areas.

The cumulative losses of tidal wetlands and riparian vegetation are having adverse impacts on the health of Virginia's tidal waters and the animals that inhabit them. Shoreline alteration linked with watershed land development has been shown to have negative impacts on water quality and a wide variety of aquatic animal populations including blue crabs, finfish, marsh birds, and the communities of organisms living in the nearshore sediments underwater (Lerberg et al., 2000; DeLuca et al., 2004; King et al., 2005; Bilkovic et al., 2006; Bilkovic and Roggero, 2008). The nearshore habitat in the Bay is negatively impacted by wetland loss and efforts to establish or restore tidal habitat and riparian vegetation that can support habitat are encouraged.

3.3.2 Hard Shore Armor Impacts

Hard shoreline armor, such as riprap revetments, bulkheads, and seawalls, has been used to protect soft estuarine shorelines for centuries. In some areas, more than half of the shoreline has been armored. For example, in San Diego Bay, armor makes up almost three-quarters of the shoreline, providing habitat for open-coast rocky intertidal species in the bay (Davis et al., 2002). Some of the subwatersheds of the Chesapeake Bay are similarly armored (Berman et al., 2000).

See also 4.1.1 Urban Considerations and Table 6 Pollutant load reductions for shoreline management practices.

The process of armoring can lead to several key physical differences between armored sites and natural sites, especially in environments in which the natural habitat at the land-water interface is "soft," such as beach or marsh, as opposed to "hard," such as rocky intertidal habitat. Armor in estuaries, especially bulkheads and seawalls, generally removes the shallowest areas of habitat available such that the land-water interface can be a meter deep or more (Jennings et al., 1999; Peterson et al., 2000; Bilkovic et al., 2006; Davis et al., 2008), often removing the entire range that is considered a refuge from subtidal predators (Ruiz et al., 1993). Sediment grain size of the area offshore armor and fringe marshes can also differ (Davis et al., 2008). In contrast, in cases in which armor replaces hard natural habitat, such as rocky intertidal, similar differences can exist (e.g., Bulleri and Chapman 2004) or the differences can be smaller (Pister, 2009).

Chemical differences may also exist between armor and natural shorelines. Armor can be constructed from materials that leach toxic chemicals (Weis et al,. 1998). Contribution of chemical signal from natural sources can differ as well: The contribution of allochthonous carbon may be lower across the land-water interface at armored sites (Jennings et al., 1999).

As a result of one or more of these physical and chemical differences, several studies have illustrated the impacts of armor on ecological communities and assemblages in both lake and estuarine systems. Generally, armored sites (bulkheads and/or riprap) have been found to have lower species diversity of motile macrofauna and infauna (Bänziger, 1995; Bilkovic and Roggero, 2008; Davis et al., 2008; Long et al., 2011), lower density of such species (Davis et al., 2008; Weis et al., 1998; Hendon et al., 2000; Peterson et al., 2000), and differences in individual body size of species that occurred in both habitat types (Hendon et al., 2000; Peterson et al., 2000; Long et al., 2011). Some studies found greater differences between vertical features (bulkheads, seawalls) and natural shorelines than between riprap revetments and natural shorelines, with the conclusion that habitat complexity is the important element (e.g., Bulleri and Chapman, 2004; Brauns et al., 2007).

Hard shore armor impacts negatively impact nearshore habitats. Hard shore armor projects are not the recommended shoreline management practice in the Bay.

3.4 Pollutant Load Reduction Currently in the Chesapeake Bay Watershed Model

Sediment inputs from tidal shoreline erosion are accounted for in the 2010 and 2017 Water Quality Sediment Transport Model (WQSTM) also known as the Bay Model while management practices for reducing these inputs are "credited" in the Chesapeake Bay Watershed Model (CBWM). The WQSTM estimates the pollutant load to the Chesapeake Bay based on estimates of unprotected or protected shorelines. The associated tidal erosion rates are applied to the unprotected shorelines. The total shoreline load is the bank load (e.g., fastland erosion) and nearshore erosion. Fastland is the tidal shoreline above water and nearshore is the tidal shoreline below water (see Figure 4). Tidal shoreline erosion from unprotected lands for the fastland and nearshore represent 65% and 35% of the total tidal shore load, respectively. Figure 4 details the tidal shore erosion from fastland and nearshore.

Importantly, this BMP differs from other urban BMPs. Currently, the tidal shoreline load is in the WQSTM and the pollutant load reduction is in the CBWM. This BMP is on the shoreline edge therefore the shoreline management practices stop sediment and nutrients from entering the Chesapeake Bay directly. This means that there is no sediment delivery factor. Therefore, the benefit and associated pollutant load reduction credit can be much higher than other urban BMPs. In addition, the BMP's pollutant load reduction is correlated to the tidal erosion rate. This means the higher the erosion at a site the higher the pollutant load reduction can be when a BMP is implemented.

The erosion of fastland from unprotected shorelines represents 65% of the total load while nearshore erosion represents 35% (i.e., 65:35) (Cerco et al., 2010). There are 92 model segments or reaches in the model which are actual shoreline lengths with variable loading rates incorporated into the appropriate model cell. Cerco et al. (2010) updated the WQSTM with spatially explicit shoreline erosion inputs developed by the CBP Nutrient Subcommittee's Sediment Workgroup.

Cerco et al. (2013) recently reported that the suspended solids budget based on the model indicated that internal production of organic solids was the greatest source of suspended solids in the Bay's mainstem. Overall sediment loads to the Bay are ranked as follows: 1) biogenic loads, 2) shoreline loads, 3) Susquehanna River, and 4) ocean sources. Shoreline management practices provide TSS reductions in the vicinity of the loading source and therefore an effective management practice to reduce sediment to the Bay which is the same conclusion found in Langland and Cronin (2003).

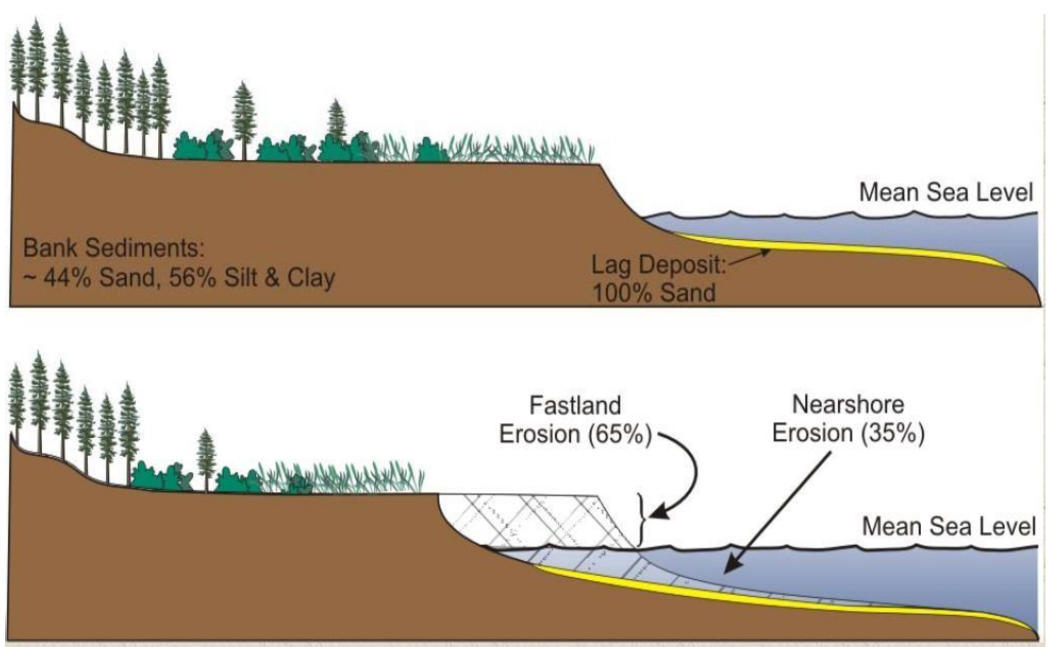

Figure 4. Tidal shoreline erosion from unprotected lands for the fastland and nearshore represent 65% and 35% of the total tidal shore load, respectively (Cerco et al, 2010; Langland and Cronin, 2003).

For more information about the CBPO model documentation and supporting tools such as CBWM, WQSTM, Scenario Builder, etc. visit the CBPO webpage at http://www.chesapeakebay.net/

In 2003, the CBPO approved nitrogen, phosphorus, and sediment removal rates for tidal shoreline management practices (see Table 5). In the 2003 Chesapeake Bay Model, nutrient and sediment removal rates for tidal shoreline erosion control practices were considered to be equal to the rates for stream restoration practices. These removal rates were initially based on a single stream restoration study and are expressed in pounds of sediment or nutrient reduction per linear foot of the project per year (Table 5).

In 2012 an Expert Panel was formed to define removal rates for individual stream restoration projects and concluded that it was inappropriate to use removal rates based on a single study given the range of stream conditions and available restoration options (Stream Restoration Expert Panel, 2014). In 2014 the CBPO approved four general protocols developed by the expert panel for estimating sediment and nutrient reduction credits associated with different types of stream restoration practices (Table 5). The stream restoration removal rates are important because shoreline management practices are commonly if not exclusively reported as stream restoration to the CBPO.

Table 5. Previous Removal rates for shoreline erosion control (management) practices.

Source	TN (lbs per foot per year)	TP (lbs per foot per year)	TSS (lbs per foot per year)
CBPO-Approved Rate in 2003	0.02	0.0025	2
Modified stream default rates, 2014	0.075	0.068	84.0 (VA) and 137.0 (MD)
The stream interim or default rate was modified and approved by the Water Quality Technical Work Group on August 28, 2014.			

3.5 Rationale for New Shoreline Management Protocol

The panel decided that the shoreline erosion control (management) pollutant load reduction rate needed to be updated based on the following:

- The current shoreline management pollutant load reduction is based on the previous CBPO approved stream restoration rate. There is no scientific basis for assuming the restoration based on a single stream study should be equivalent to “all” shoreline management practices. Table 6 outlines the available studies for TN, TP, and TSS pollutant loads compared to the CBPO policy thresholds.

Table 6. Pollutant load reductions for shoreline management practices.

Source	TN (lb per foot per year)	TP (lb per foot per year)	TSS (lb per foot per year)	Study Location
Ibison, 1990	1.65[2]	1.27[2]	7,000[3]	Virginia
Ibison, 1992	0.81[4]	0.66[5]	2,800[6]	Virginia
Proctor, 2012	NA	0.38 or 0.29[7]	1,180[8]	Virginia
MDE, 2011*	0.16	0.11	451	Maryland
Baltimore County mean (Forand, 2013)	0.27	0.18	749	Maryland
CBPO Scenario Builder (CBP, 2012)	0.02	0.0035	2.55	CBPO policy threshold that comes from one stream restoration site in Maryland
Revised stream default rate, 2014	0.075	0.068	248[9]	CBPO 2014 updated Stream Panel Report

[1]MDE data was based on Baltimore County Department of Environmental Protection and Sustainability (DEPS) analysis of twenty three individual shoreline restoration projects completed by Baltimore County DEPS Capital Projects and Operations. Median values were used and reported (Forand, 2013).
[2] Table 5 on p.43 (Ibison, 1992)
[3] calculated from Table 5 on p. 43 (Ibison, 1992) (sediment loading rate 3.5 tons/ft-yr)
[4] Table 2 on p. 38 (Ibison, 1992)
[5] Table 3 on p. 40 (Ibison, 1992)
[6]Calculated from (Ibison, 1992) (sediment loading rate 1.4 tons/ft-yr)
[7] Calculated using numbers on p. 25 and 2,300 ft project length on p. 18 (Proctor, 2012)
[8] Calculated using numbers from p. 25 (Proctor, 2012) and 2,300 ft project length on p. 18 (Proctor, 2012)
[9] Sediment delivery ratio has to be applied for delivered load as these are edge of field values

- Shoreline management practices were "lumped together" and reported with stream restoration practices. Therefore, there is no accurate accounting for the implementation of these practices in the Chesapeake Bay watershed. The reporting for shoreline

management practices is inaccurate. For example, states report no shoreline management projects to CBPO through National Environmental Information Exchange Network (NEIEN).
- Shoreline erosion is one of the greatest sources of sediment and turbidity to the Chesapeake Bay and tributaries. Because there is no lag time associated with transport and delivery of sediment, the benefits of shoreline management practices in reducing turbidity are immediate.
- The literature review by the Expert Panel supports development of protocols for estimating pollutant shoreline management rates that can be tailored using locally available data.

Therefore, shoreline management protocols and associated pollutant load reductions should be developed for this practice. A tailored protocol for shoreline management through the expert panel process will better reflect the TN, TP, and TSS pollutant load reductions for the Chesapeake Bay TMDL and local government planning. In addition, better reporting, tracking, and verification are needed to reflect the number and extent of shoreline management practices in the Chesapeake Bay.

Section 4. Basic Qualifying Conditions for Individual Projects

The shoreline management panel recommendations are intended to support the CBPO, the state, and the local governments to provide the best available techniques to the land that promote habitat and prevent shoreline erosion. These practices will prevent excessive pollutants from entering the Bay and impairing habitat. In addition, these shoreline management practices are intended for implementation where needed and where feasible. Appendix D provides more detail about this shoreline management approach to include, why it is important, and how to implement a shoreline management approach in the Chesapeake Bay watershed. All aspects of shoreline management should support the policies in place or promote better practices within these policies and permits. Finally, although MD and VA are highlighted here, the Panel acknowledges the tidal range extends to Delaware and the District of Columbia and these recommendations apply there as well.

Not all shoreline management projects may qualify for sediment or nutrient reduction credits. The Panel outlined the qualifying conditions for acceptable shoreline management restoration credit. Additionally, environmental and habitat considerations, urban considerations, and unintended consequences are outlined here to promote the most effective shoreline management.

Maryland and Virginia's preferred shoreline management approach is to use living shorelines where appropriate to prevent shoreline erosion and to protect the associated habitat. Maryland is a "high water state" meaning the jurisdictional line is at MHW (mean high water) and Virginia is a "low water state" meaning the jurisdictional line is at the MLW (mean low water). The policy and permit structure differs in the states, but the goals to protect property, prevent erosion, promote nearshore water habitat, and prevent unintended consequences are similar for the states. More information about the policy and permits is provided in Appendix E.

4.1 Basic Qualifying Condition Rationale

Shoreline management should be implemented in areas where there is a demonstrated need to control erosion to the Bay and where there will be a water quality benefit from the practice. The panel also considered habitat benefits as much as possible within the panel framework. The following benchmarks are commonly used to determine if the shoreline management practice should be considered: 1) site energy; 2) water depth offshore; 3) fetch; and 4) erosion rate (CBF, 2007). The jurisdictions (state) policy and procedures for shoreline management outline thresholds and qualifying conditions for the projects.

For example, in Maryland the MDE (2008) guidance outlines the "preliminary considerations for erosion control of your waterfront property" guidelines and suggests contacting professionals, the state offices of MDE, MD DNR, US Army Corps of Engineers, and/or the Soil Conservation District Office. In Maryland and Virginia these policies are currently being updated. Finally, there is no Chesapeake Bay TMDL pollutant load reduction credit allowed for projects that are required for mitigation.

Shoreline environment and habitat should be considered in the planning, implementation, and maintenance phases. Erosion and property loss are important to protect. Additionally, the nearshore waters should be protected from non-point sources (NPS) pollution and also protected from disturbances that are associated with shoreline management. Practices should be implemented that are appropriate for the site and are the minimum necessary to address the identified erosion problem. For example, the practice footprint should be minimized to reduce the amount of clearing and grading and impacts to other natural resources.

Shoreline management should be part of the larger watershed restoration and preservation effort that include best practices such as using vegetative buffers upland of the shoreline practices, protecting natural resources where possible, and implementing sound design and construction standards. A shoreline management approach considers the site's shoreline reach, the factors that influence the reach, property owners, spatial parameters to address shoreline erosion, and helps frame the problem. A shoreline management approach in the Chesapeake Bay (see Appendix D) should be considered for sustainable shoreline management.

4.1.1 Urban Considerations

Urban areas can contain land use, available space, and other considerations that are not encountered elsewhere. For example, the Panel realized that preferred living shorelines may not be possible in urban areas that contain port facilities, marine industrial facilities, and/or other marine commercial areas. There may not be available space in the urban area and alternative shoreline management strategies may be needed. In addition, benchmarks such as fetch, boat traffic, and others can be limiting factors in urban development. Urban considerations may determine the shoreline management practice. However, the basic qualifying conditions outline the criteria for Chesapeake Bay TMDL pollutant load reduction eligibility for these urban practices.

4.1.2 Sea Level Rise Considerations for Shoreline Management Practices

The Shoreline Management expert panel realizes that future sea level rise (SLR) considerations for shoreline management practices are needed. The design, maintenance, and ultimate effectiveness can be impacted by rising waters and/or more intense storm events. Based on the available information there is a need to consider the future impacts to the shoreline management options provided in this panel report.

The Chesapeake Bay coastal states are vulnerable to rising seas and subsequent coastal wetland loss. The panel underlines the need for better designs that incorporate SLR, practices that allow landward migration for wetland systems are ideal, and additional research needs were identified (Section 7). See Appendix F for more SLR considerations for shoreline management practices.

4.1.3 SAV Habitat

The panelists researched and discussed the application of the Chesapeake Bay SAV goals to set thresholds for the basic qualifying conditions criteria. The aim for SAV basic qualifying conditions criteria was to aid SAV future growth by providing incentive to consider this natural resource habitat through the Chesapeake Bay TMDL pollutant load reduction credit (or lack of pollutant load reduction credit). SAV research findings and current research preliminary findings were presented and vetted through the panel process.

Based on past records, SAV occurs where horizontal shoreline erosion is less than 2 ft yr^{-1} (Karrh et al., 2011). Shoreline erosion is also a natural process that can contribute sand and other sediment sources that promote nearshore habitats, such as SAV. See also, *Section 3.2 Shoreline Management and Habitat Impacts*. In addition, stone structures in the water have negative impacts on SAV. Patrick et al. (*in press*) reported that SAV distribution was negatively impacted when more than 5.4% of the shoreline contained stone structures in the watershed. SAV habitat should be protected to meet the Bay-wide SAV goal.

The panel vetted the idea to not provide a Chesapeake Bay TMDL pollutant load reduction for projects in areas with horizontal shoreline erosion that was less than 2 ft yr^{-1} and to include this threshold as a basic qualifying condition. This threshold was not adopted as a basic qualifying condition. An analysis to further refine shoreline erosion rates that included eroded volume was conducted in an attempt to provide a compromise for a qualifying condition yielded inconclusive results. Based on these SAV discussions, the panel cited that more research was needed (Section 7) to support a SAV specific basic qualifying condition.

4.2 Basic Qualifying Conditions for Individual Projects

The basic qualifying conditions that are outlined in Table 7 are criteria a shoreline management project must meet in order to receive Chesapeake Bay TMDL pollutant load reduction. Projects that do not meet these basic qualifying conditions (e.g., a bulkhead or seawall where a living shoreline is feasible) do not receive Chesapeake Bay TMDL pollutant load reduction. Finally, the Panel recommends that no Chesapeake Bay TMDL pollutant load reductions should be provided for projects that impact Chesapeake Bay Preservation Act protected vegetation without mitigation.

Table 7. Criteria for Chesapeake Bay TMDL pollutant load reduction for shoreline management practices. These are the basic qualifying conditions.

Shoreline Management Practice	The Practice Must Meet these Criteria for TMDL Pollutant Load Reduction[1]
Living Shoreline – a) nonstructural; b) hybrid system including a sill; and c) hybrid system including a breakwater	1. The site is currently experiencing shoreline erosion or is replacing existing armor. The site was graded, vegetated, and excess sediment was removed or used.[2] AND 2. When a marsh fringe habitat (a or b) or beach/dune habitat (c) is created, enhanced, or maintained.
Revetment AND/OR Breakwater system without a living shoreline	1. The site is currently experiencing shoreline erosion, AND 2. A living shoreline is not technically feasible or practicable as determined by substrate, depth, or other site constraints. AND 3. When the breakwater footprint would not cover SAV, shellfish beds, and/or wetlands.
Bulkhead/Seawalls	1. The site is currently experiencing shoreline erosion. AND 2. The site consists of port facilities, marine industrial facilities, or other marine commercial areas where immediate offshore depth (e.g., depths deeper than 10 feet 35 feet from shore) precludes living shoreline stabilization or the use of a breakwater or revetment.
[1]Projects that impact the Chesapeake Bay Preservation Act protected vegetation without mitigation receive no Chesapeake Bay TMDL pollutant load reduction. Further, WQGIT agreed to allow States to determine, on a case-by-case basis, when the unintended consequences of negative impacts to wetlands and SAVs caused by these shoreline management techniques, outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit.	

The basic qualifying conditions are based on the panel's previous literature review, panel discussions and best professional judgment. See also, Appendix G that includes additional shoreline management site conditions and benchmarks.

Section 5. Rationale, Methods, and Examples for New Shoreline Management Protocols

5.1 Literature Review to Support New Shoreline Management Protocols

The Panel's review of available science per the panel process outlined in WQGIT (2010) included rigorous reviews, report outs to the group, and discussions. The major focus for this literature review section is to present the supporting science for the shoreline management protocols for sediment and nutrient pollutant load reductions in the Chesapeake Bay. The science and past CBPO EPA panel precedent support this panel's recommendations for providing pollutant load reductions for shoreline management practices that:

1. prevent erosion and associated sediment from entering the Bay (Protocol 1: Prevented Sediment); and
2. shoreline management practices that incorporate vegetation
    a. promote denitrification and remove nitrogen (Protocol 2: Denitrification);
    b. promote accretion and sedimentation that remove sediment and phosphorus (Protocol 3: Sedimentation); and
    c. promote vegetative uptake and associated nutrient removal (Protocol 4: Marsh Redfield Ratio).

The Panel's research included their own expertise and research. In addition, the Panel conducted a literature review of over 200 publications that covered multiple topics in the coastal management field, including nutrient and sediment efficiency, policy, reporting, tracking and verification, shoreline management practice types, case studies, and erosion. The Panel's research and findings intersect with wetlands, especially coastal wetlands. A future Wetlands Expert Panel will convene and it is anticipated that the Shoreline Management Panel's recommendations will the foundation of future work done by the Wetland Expert Panel.

5.1.1 Prevented Sediment

Erosion of unconsolidated shorelines is a major source of sediment to the Chesapeake Bay. Tidal erosion is the major driver for property owners and for local jurisdictions to implement shoreline management practices. Langland and Cronin (2003) summarizing work of the Chesapeake Bay Program's Sediment Work Group emphasized that shoreline erosion (nearshore and fastland) accounts for approximately 57% of the sediment source loads to the Bay (65% fastland and 35% nearshore). Riverine (watershed and streams) sources at the fall line account for 29% of the total load. Shoreline management practices are implemented to stop this tidal erosion. These practices prevent sediment and associated nutrients from entering the Bay. In addition, the recently approved urban stream restoration expert panel included a prevented sediment protocol for the urban stream corridor. In summary, shoreline management practices prevent tidal shore erosion and thereby protect the property as well as prevent pollutants from entering the Bay.

Section 5.2 Recommendations for Shoreline Management Sediment and Nutrient Load Reductions includes recommendations that were made to reduce unintended consequences for the shoreline management's prevented sediment protocol. These recommendations include discounting the sediment protocol's pollutant load reduction if a project cannot verify sufficient bank stability. In addition, a pollutant load reduction cap (Appendix C) will ensure that the state basin model segment does not exceed the available pollutant load reductions. Therefore, the unintended consequences were reduced.

5.1.2 Tidal Marsh Denitrification

Tidal marsh, especially fringe tidal marsh, sediment and nutrient pollution removal rates can be used to estimate the added benefit for shoreline management practices that add marsh habitat. Upland or terrestrial source nutrient and sediment loading to the coastal nearshore waters has increased with increased urbanization. Tidal marshes can ameliorate some of these loadings due to: 1) their location between the upland and the coast; and 2) their ability to transform nutrients (Nixon, 1980; Valiella, 2000) and trap sediment (Jordan et al., 1986).

Denitrification is the anaerobic microbial conversion of nitrate (NO^{-3}) to nitrogen gas (N_2). Denitrification removes nitrogen from the system (Seitzinger, 1988; Tobias et al., 2001; Groffman and Crawford, 2002). Denitrification rates vary based on the tidal inundation period, salinity, sample location in the marsh, sample time, catchment size and characterization, denitrification method, sediment carbon content, and other factors. Additional research for shoreline denitrification and quantifying the impact these variables have on denitrification is an identified research need. All geographically relevant marsh studies were used without screening for the variables previously discussed. Therefore, the panel gathered a robust dataset for the management recommendation.

The Panel focused on tidal marsh literature since the findings were most applicable to shoreline management practices. Although there is extensive wetland research available, the Panel's professional judgment was that the wetland studies were not as applicable to the panel work since wetland systems most often have large surface areas compared to shoreline projects.

Research found that denitrification is a major nitrogen removal process in marsh vegetation. Greene (2005) and Merrill (1999) found that tidal marshes in the upper Patuxent estuary sequester nitrogen and phosphorus. For example, the upper Patuxent estuary's mean denitrification rate over 25.8 km^2 was 1,040 kg N d^{-1}. This tidal marsh denitrification could remove 24% of N inputs to the upper Patuxent. Annual net denitrification rates for the Chesapeake Bay marsh sediments were estimated at 60 µmol N m^{-2} h^{-1} (Merrill and Cornwell, 2002). Additional work by Seitzinger (1988) found five fringe salt marshes in Narragansett Bay, Rhode Island, showed denitrification rates up to 420 µmol N_2 m^2 hr^{-1} to intercept and transform land-derived nitrogen loads (Davis et al., 2004). The Dyke Marsh is a tidal freshwater marsh on the Potomac River. The mean denitrification rate was 147 µmol N m^{-2} h^{-1}. Using this rate for the Dyke Marsh area, the potential N removal is 14,600 kg yr^{-1} (Hopfensperger et al., 2009).

Marsh vegetation are sites for denitrification and other physical and chemical pathways, too. Tidal marshes are effective at trapping sediment both as individual grains and as flocculants. Tidal marsh vegetation plays a role by reducing velocity and breaking up turbulent eddies that might result in resuspension of deposited sediment (Christianson et al., 2000). Merrill (1999) reported that burial in the Patuxent River tidal marshes can remove up to 24% of nitrogen and 68% of phosphorus that enters the upper Chesapeake Bay subestuary. Marshes trap 35% of the nitrogen and 81% of the phosphorus load before entering the estuary where the nutrients would be recycled, exported, or buried. Therefore, vegetation in shoreline management practices will remove total pollutants through other pathways that are captured in Protocol 3 and 4.

In summary, the literature review found that denitrification was an important nitrogen removal pathway in vegetative systems. The nitrogen removed in tidal marshes and fringing marshes can represent estimates for shoreline management denitrification.

A summary for the tidal marsh literature and associated denitrification rates are included in Appendix H. This data was used in Section 5 for the denitrification protocol. Denitrification rates reported per area were used and denitrification rates reported per mass (e.g., Windham and Meyerson, 2003; Findlay et al., 2003; Otto et al., 1999, etc.) were not used for the protocol's pollutant load reduction. Denitrification rates reported per mass cannot be converted to a per area value.

The available denitrification information (Appendix H) was compiled and grouped so that one value was reported per study. If more than one value was available per study the average was used. The grand median was 78 µmol m^{-2} h^{-1} or 85 lbs ac^{-1} yr^{-1}.

5.1.3 Sedimentation: Sediment Trapping through Accretion

The study of marsh accretion rates has been conducted for a variety of reasons, including understanding of marsh dynamics, and most recently, related to the ability of marshes to maintain their surface elevations in light of sea level rise. The methods of study have ranged from differential total suspended sediment (TSS) concentrations between flood and ebb tides, inference from sediment cores using radioisotope methodologies, direct measurement of changes in marsh surface elevation over time, to direct measurement using marker horizons or filters. Accretion in marshes is due to the trapping of sediment and organic matter and associated TN and TP removal from the system.

Deposition is the settling of material on the marsh surface. The net balance between deposition and removal processes is accretion (Neubauer, 2002). The elevation of the tidal marsh over time is related to the interaction of increases in sea level, local subsidence, decomposition, and surface sediment compaction decreasing the marsh surface, while accumulation of sediment and input of local organic matter from local plant production result in marsh surface elevation increases. In most marshes these processes are in relative balance (Callaway, et.al. 2012). Sediment is delivered to the marsh surface through tidal inundation; waves and storm surges (Nyman, 2006).

Marsh accretion may also occur through vegetative growth, primarily subsurface root growth. The total accretion due to both the sediment delivered to the marsh surface and vegetative growth. Neubauer's research summary for the midAtlantic tidal marshes reported most accretion rates in marshes as 6.85 mm yr^{-1}(n=20). In another study conducted in Georgia, marsh type impacted accretion values, with salt marsh, brackish, and freshwater marsh accretion rates of 1.91 mm yr^{-1}, 4.41 mm yr^{-1}, and 7.78 mm yr^{-1}, respectively (Loomis and Craft, 2010).

Accretion was determined to be higher at the marsh edge which most closely mimics living shoreline projects (Leonard and Croft, 2006). Fringing marshes typically constructed as part of living shoreline projects may have comparable sediment retention capacity as extensive marshes if they have similar edge habitat where the highest rates of deposition occur (Christiansen et al., 2000; Neubauer et al., 2002). Morgan et al. (2009) reported sediment trapped at the edge of the marsh from 2 to 30 g m^{-2} d^{-1}. Larger marsh systems also accreted near the edge even when losing sediment overall (e.g., Blackwater marshes as reported by Stevenson et al. (1985)). The science review supported accretion as an important removal mechanism that living shorelines provide (see Appendix I).

Many studies report vertical accretion in millimeters or centimeters per year. In order to convert this measurement to a weight for crediting purposes, the bulk density of the material is needed. Callaway et al. (2012) provided the bulk density of restored marsh sediments by depth and location within the marsh (Table 8). Table 8 presents the results of four transects, two in a natural marsh and two in a restored marsh. The transects were core sampled to represent low marsh, mid marsh, and high marsh locations and were further sectioned by 10 centimeter increments.

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Table 8. Bulk density results by marsh type, marsh location, and core depth (g/cm^3).

Marsh Location	Core Depth				
	0-10 cm	10-20 cm	20-30 cm	30-40 cm	40-50 cm
Natural Marsh					
Low	0.4700	0.5175	0.4955	0.5385	0.5330
Mid	0.4320	0.3775	0.3760	0.4460	0.4450
High	0.3710	0.3600	0.4115	0.4630	0.4350
Average	0.4243	0.4170	0.4277	0.4825	0.4710
Restored Marsh					
Low	0.3895	0.4890	0.5430	0.7265	0.8000
Mid	0.3915	0.4930	0.4980	0.6160	0.7985
High	0.5975	0.7610	0.8255	0.8035	0.9595
	0.4595	**0.5810**	**0.6222**	**0.7153**	**0.8527**
Average All Groups	***0.4419***	***0.4990***	***0.5249***	***0.5989***	***0.6618***
	N	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Survey	4	456,446	258,145	259,933	832,619

The researchers found no significant difference between the natural marsh and the restored marsh in the bulk density for the 1 to 10 cm or the 10 to 20 cm core interval categories, but the deeper cores were found to be significantly greater with the restored marsh. However, to ensure a conservative estimate for the sediment accretion credit a bulk density of 0.3895 g/cm^3 was selected, representing the restored low marsh mean. This will result in a conservative sediment reduction credit. Additional information about sedimentation is provided in Appendix I

The results from the sediment core, horizontal marker, and sediment flux studies were used to determine the annual sediment accretion credit for marsh creation associated with shoreline management projects (Table 9). An ANOVA found that only the survey methodology resulted in annual sediment accretion rates that were significantly different than the other methodologies. Therefore the results from the sediment core, horizontal marker, and sediment flux studies were used to determine the annual sediment accretion credit for marsh creation associated with shoreline management projects.

Table 9. Pounds of sediment per acre per year derived by various methodologies.

	N	Mean	Std. Dev.	Minimum	Maximum
Survey	4	456,446	258,145	259,933	832,619
Core	30	8,329	4,373	1,428	19,194
Horizontal Marker	7	14,486	9,413	5,908	27,800
Sediment Flux	2	2,855	1,514	1,784	3,926

Since the data is highly variable and to account for uncertainty, the median value of 6,959 pounds TSS/acre/year (not shown) was used for the credit based on sediment accretion in tidal marsh restoration associated with shoreline management projects. For comparison the mean for data was 8,489 pounds TSS/acre/year.

Tidal marsh sediments are comprised of organic and inorganic autochthonous and allochthonous material in variable proportions. The nutrient content of this material can be permanently removed through burial (Libes 1992, Nixon 1980) as long as there is not physical disturbance to the system. Few studies have looked at the concentrations of nutrients in tidal marsh sediments. Zelenke and Cornwell (1996) and Cornwell et al. (1994) studied four tidal marsh sediments in the Chesapeake Bay to determine the relative importance of sedimentation in phosphorus retention which includes phosphorus data that can be used to estimate removal rates associated accretion. The four systems include, the Monie Bay National Estuarine Research Reserve, Otter Creek National Estuarine Research Reserve, Jug Bay National Estuarine Research ReservePatuxent River and Choptank River. The studies involved the measurement of nutrient concentrations in vertical core profiles. Cores were divided into 3, 5, and 10 cm sections which were dried and weighed to determine bulk density and phosphorus concentration. While this study also determined areal accretion rates, for the purpose of this protocol only phosphorus data will be discussed. Monie Bay, Jug Bay and Otter Creek had comparable total phosphorus (TP) concentrations within the top 10 cm ranging between 0.4 to 0.6 mg/g with higher variability at greater depths. The Patuxent site had substantially greater TP concentrations (>1.0 mg/g). Using these same data, Cornwell et al. 1994 reported a mean sediment concentration of 0.76 mg/g (0.17) in surface sediments and 0.66 (0.04) mg/g in buried sediments. The authors indicate that phosphorus burial in Monie Bay does not play a significant role in phosphorus retention and are approximately one fourth the concentration of subtidal sediments in the Chesapeake Bay. Therefore, given the limited studies on phosphorus retention through accretion this protocol will use 0.76 mg/g as an average TP concentration (5.289 lbs TP/acre/yr) as a conservative default value for this protocol.

5.1.4 Marsh Redfield Ratio

Vegetation in marshes and wetlands are active areas for nutrient cycling. The panel researched and discussed the vegetative uptake and associated pollutant removal due to the vegetation in marsh and wetland systems. Based on this research there was not enough available information to support a protocol for the vegetative uptake and ultimate removal for total nitrogen and total phosphorus. In addition, the vegetative uptake findings often overlapped with the denitrification and sedimentation nutrient removal pathways that are outlined in protocols 2 and 3. Therefore, the marsh Redfield ratio was used as a conservative estimate of the nitrogen and phosphorus removed from the Bay by vegetation.

The marsh Redfield ratio represents the nitrogen and phosphorus that is biologically and chemically unavailable to nearshore waters and Chesapeake Bay due to vegetative processes. These processes include the above ground and below ground nutrient cycles. The marsh C:N and N:P are reported in Table 10. Nyman et al. (2009) analyzed C, N, and P in the marsh vegetation tissue in laboratory conditions where neither salinity nor nutrients significantly impacted the N:P ratios in the plant tissues. Based on these results the marsh Redfield ratio for C:N:P was 1,454:23:1.

Table 10. Marsh Redfield ratio findings (Nyman et al., 2009).

C:N	N:P	C:N:P
56:1	8:1	
ND	44.01:1	
ND	25:1	
ND	16.2:1	
49.04:1	ND	
84.5:1	ND	
60:1	ND	
62:1 (mean)	**23:1 (mean)**	**1,454:23:1**
Notes: The mean C:N was 62:1 and N:P was 23:1. The resulting C:N:P was 1,454:23:1.		

The marsh vegetation area and associated production for that vegetated area represents the mass per year. The marsh vegetation reported for the aboveground and below ground aerial production is in Appendix J. The grand median value was 1,458 g dry matter m^{-2} yr^{-1}. This median vegetative production value was used to adjust the C:N:P to 1,455:23:1. The resulting N:P was 23:1. This represents the nitrogen and phosphorus removed from the Chesapeake Bay per square meter shoreline management vegetation per (i.e., 23 g TN m^{-2} and 1 g TP m^{-2}). Converting this TN and TP to pounds per acre resulted in the following pollutant load reductions: 1) 205 TN lb ac^{-1} and 2) 9 TP lb ac^{-1}. Instead of a one-time credit, the Watershed Technical Workgroup requested the pollutant load reduction be annualized over the expected life of the marsh. Therefore, the panel estimated the shoreline management practice lifespan was 30 years. Based on the lifespan, the panel recommended protocol 4 Marsh Redfield Ratio pollutant load reduction is of 6.83 pounds nitrogen/acre/yr and 0.3 pounds/phosphorus/acre/yr.

5.2 Recommendations for Shoreline Management Sediment and Nutrient Load Reductions

The Panel's recommended protocols for shoreline management pollution reduction are provided here. The four protocols include:

1. Prevented Sediment
2. Denitrification
3. Sedimentation
4. Marsh Redfield Ratio

The protocol supporting rationale and research were provided in *Section 5.1 Literature Review to Support Shoreline Management Protocols*. The basic qualifying conditions for individual projects were outlined in *Section 4 Basic Qualifying Conditions for Individual Projects*. A shoreline management project must meet the basic qualifying condition to qualify for and receive TMDL pollutant load reduction credit. Examples to use the basic qualifying conditions and protocols are included in *Section 5.3 Examples*. Default values are provided, as appropriate, however the panel recommended site sampling and provided guidelines in Appendix K.

The literature review to support development of the four protocol methods were provided in *Sections 5.1.1 Prevented Sediment* through *5.1.4 Marsh Redfield Rat*io.

5.2.1 Protocol 1. Prevented Sediment

The prevented sediment protocol follows a three-step process to compute a mass reduction credit for prevented sediment:

1. The first step should determine whether SAV is already present and if so the local jurisdictions or states should decide whether credit should be provided toward jurisdictional Bay restoration goals due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

2. Estimate shoreline erosion rates and annual sediment loadings

3. Estimate reduction attributed to restoration.

Step 1. *Determine if existing SAV are present. Consult local State Agency for local SAV inventories or conduct on-site sampling.*

Step 2. *Estimate shoreline sediment erosion rate*

Estimates of sediment loss are required as a basis to this protocol. To estimate shoreline erosion rates in Maryland for Step 1 of this protocol, the Maryland Department of Natural Resources Coastal Atlas website can be used to determine erosion rates. Use the S*horelines Rates of Change* layer and the Identify tool to obtain the rate for a given site. If a transect is unavailable at the specific location, use the nearest transect. To estimate shoreline erosion rates in Virginia use closest existing data from VIMS and additional updated refinements or data sets (e.g., Scott Hardaway's AMBUR). The calculations discussed herein should be performed on a reach basis along the shoreline, with overall reported values consisting of a weighted-average of each reach (weighted by the shoreline reach lengths). The shoreline should be broken into homogenous reaches represented by the shoreline's natural breaks or on or around 1,000 feet long. Finally, projects in DE and the District of Columbia should obtain and vet shoreline erosion rates with the local permitting authority.

To estimate sediment erosion rates using actual data, the volume of prevented erosion must be determined. Using the equation V=LEB, where V=volume of sediment (cubic feet), L=length of shoreline (feet) project, E = Shoreline recession rate (feet/year) and B=bank height (feet), this can be calculated. For new or current projects, length of the project and average bank height can be obtained from the project design specifications. For old projects, this data can be taken from engineering plans. Shoreline erosion (recession) rate was determined as above.

This equation yields a volume expressed in cubic feet per year. Cubic feet are converted to pounds using a soil bulk density of 93.6 lb/ft^3 (Ibison, 1992). This 93.6 lb/ft^3 is the panel's recommended default bulk density value.

If there is better information for the bulk density such as through site specific site monitoring, then this data could be used. Applying the bulk density should be documented and coordinated with the state agency that is responsible for tracking, verifying, and reporting these data.

Step 3. *Estimate shoreline restoration efficiency*

Shoreline erosion is estimated in Step 2, but not the efficiency of shoreline restoration practice in preventing bank erosion.

The panel determined that full efficiency or 100% should be used since the practice prevents the fastland and nearshore erosion, however the protocol only accounts for the fastland sediment prevented from eroding. Since the nearshore sediment prevented is not accounted for in this protocol, 100% efficiency for the shoreline management practice is a conservative estimate.

If there is better information for the practice efficiency available, such as through site specific site monitoring, then this efficiency could be used. Applying the efficiency should be documented and coordinated with the state agency that is responsible for tracking, verifying, and reporting this data.

Step 4: *Adjust prevented sediment load to eliminate coarse grained sand*

The final TSS pollutant load reduction should be reduced by the sand component in the sediment prevented by the practice to assure that TMDL credit is not given for reductions in sand, which as previously indicated, can be beneficial. Reducing the reduction credit based on the percent sand content would better align tidal shoreline practices with upland BMPs. Almost all of the sand from upland watersheds is lost to floodplain and channel storage during the transport process and accounted for by the watershed model's sediment delivery factor. Therefore, the sediment reduction credit for these BMPs is almost entirely based on fine sediment. Halka (2013) provided estimates for fines in Maryland and Virginia (see Table 3 Chesapeake Bay shoreline characteristics and shoreline erosion mass loading). Table 11 shows the values for fines, coarse sediment (sand), and organics. The sand reduction factor should be applied to the final TSS load.

Table 11. Chesapeake Bay shoreline soil characteristics (Halka, 2013) and the sand reduction factor.

State	Loading (kg/m/d)			Sand Reduction Factor
	Total	Fines	Coarse	
Maryland[1]	2.43	1.34	1.02	0.551
Virginia	1.01	0.34	0.67	0.337
Source: Chesapeake Bay shoreline characteristics and shoreline erosion mass loading (averaged) (Halka, 2013).				

If better information for the % fines and % sand available, such as through site specific site monitoring, then this information could be used. Applying the resulting factor should be documented and coordinated with the state agency that is responsible for tracking, verifying, and reporting this data.

Bank Instability Reduction for Prevented Sediment

The panel recognized that tidal shoreline management projects that do not adequately address the critical angle of repose are at a continued risk of erosion due to waves and usual storm events, which impact the base of the bank. This is supported by Clark et al. (2004) who studied the bluffs at Calvert Cliffs and found the angle of repose was critical for maintaining the bank stability. The Expert Panel felt that projects that were at risk for failure because of slopes greater than the angle of repose should be allowed only 50% of the credit allowed under Protocol 1.

[1] The District of Columbia and Delaware should use MD. Numbers.

However, The WQGIT felt that local or state agencies should have the flexibility to give partial or not give any credit based on a site by site basis. Therefore, the shoreline management project should provide detailed bank stability analysis to the local reporting agency to document that no additional sediment and associated pollutants will enter the nearshore waters to include the following conditions: 1) the project was graded and vegetated so that the bank is stable and 2) excess sediment was removed offsite so that the sediment does not enter the nearshore waters. Bank analysis can demonstrate the site is stable with a minimum risk of erosion.

This should be coordinated with the local reporting authority to ensure proper methods, reporting, and requirements are done and are accepted by that authority so that the project meets this basic qualifying condition. The local or state agency may decide not to issue the credit based on the information regarding site slope and stability assessment that is provided.

5.2.2 Protocol 2. Denitrification

This credit is for marsh denitrification and based on the denitrifying capabilities of marsh soils. The pollutant load reduction is based on the square footage of wetland planting in conjunction with a shoreline management project. This credit applies to nitrogen. Also step 1 under protocol 1 applies here as well.

The denitrification literature was reviewed, synthesized, and selected to include for the denitrification protocol. See *Section 5.1 Literature Review to Support Shoreline Management Protocols* and associated appendices for more information. The denitrification rates were converted to pounds of nitrogen per acre per year. As mentioned earlier, methods that yielded denitrification rates per mass (e.g., ng N g^{-1} h^{-1}) could not be converted to pounds of nitrogen per acre per year and were not used for this analysis. In order to provide a conservative estimate of the pounds of nitrogen removed through the denitrification process, the grand median value of 85 pounds nitrogen/acre/year were used for this protocol.

Step 1. *Determine the total post construction area of the net increase in marsh plantings and convert to acres.*

This may be taken from the restoration drawings after confirmation in the field through as-builts. Future credit should be based on field verification of survival of the initial planting and any expansion of the restored marsh area due to either re-enforcement planting or natural expansion.

Step 2. *Multiply the acres of marsh planting by the unit denitrification rate (85 pounds total nitrogen/acre/year).*

In-lieu of the default denitrification pollutant load reduction, site determined values may be substituted, if based on scientifically defensible study design. Applying the site denitrification should be documented and coordinated with the state agency that is responsible for tracking, verifying, and reporting this data.

5.2.3 Protocol 3. Sedimentation

This credit is based on the sediment trapping capabilities of both vegetative planting and/or on sediment deposition behind shoreline management structures. The pollutant load reduction is based on the square footage of wetland planting in conjunction with a shoreline management project. This credit uses median accretion rates and a conservative bulk density as described in *Section 5.1.3 Sedimentation: Sediment Trapping through Accretion*. This credit applies to sediment and phosphorus. Also step 1 under protocol 1 applies here as well.

Step 1. *Determine the total post construction area of the net increase in marsh plantings and convert to acres.*

This may be taken from the restoration drawings after confirmation in the field through as-builts. Future credit should be based on field verification of survival of the initial planting and any expansion of the restored marsh area due to either re-enforcement planting or natural expansion.

Step 2. *Multiply the acres of marsh planting by the unit sedimentation value (6,959 lbs total suspended solids/acre/yr).*

Step 3. *For total phosphorus load removed multiply the acres of marsh planting by 0.76 mg/g (conversion = 0.00076) (5.289 lbs total phosphorus/acre/yr).*

In-lieu of the default sedimentation pollutant load reduction, site determined values may be substituted, if based on scientifically defensible study design. Applying the site values should be documented and coordinated with the state agency that is responsible for tracking, verifying, and reporting this data.

5.2.4 Protocol 4. Marsh Redfield Ratio

This protocol is based on vegetative uptake of nutrients for vegetative growth in marshes. The pollutant load reduction is based on the square footage of wetland planting in conjunction with a shoreline management project. Future credit should be based on field verification of survival of the initial planting and any expansion of the restored marsh area due to either re-enforcement planting or natural expansion. This credit applies to nitrogen and phosphorus. Also step 1 under protocol 1 applies here as well.

The marsh Redfield Ratio literature that was outlined in *Section 5.1.4 Marsh Redfield Ratio and Appendix J Marsh Redfield Ratio Data* was reviewed, synthesized, and summarized for the marsh Redfield ratio protocol. In addition, the median TN and TP removal values were converted to pounds of nitrogen per acre. In order to provide a conservative estimate of the pounds of nitrogen and phosphorus removed from the system when vegetation is present, the grand median values of 205 pounds nitrogen/acre and 9 pounds/phosphorus/acre were used for this protocol. Instead of a one-time credit, the Watershed Technical Workgroup requested the pollutant load reduction be annualized. Therefore, the panel estimated the shoreline management practice lifespan was 30 years. Based on the lifespan, the panel recommended protocol 4 Marsh Redfield Ratio pollutant load reduction is of 6.83 pounds nitrogen/acre/yr and 0.3 pounds/phosphorus/acre/yr.

This Marsh Redfield Ratio pollutant load reduction credit is based on vegetative uptake of nutrients for vegetative growth in marshes. This credit applies to nitrogen and phosphorus.

Step 1. *Determine the total post construction area of the net increase in marsh plantings and convert to acres.*

This may be taken from the restoration drawings after confirmation in the field through as-builts.

Step 2. *Multiply the acres of tidal marsh planting by the unit marsh Redfield ratio value (6.83 pounds total nitrogen/acre and 0.3 pounds total phosphorus/acre).*

In-lieu of the default pollutant load reduction, site determined values may be substituted, if based on scientifically defensible study design. Applying the site values should be documented and coordinated with the state agency that is responsible for tracking, verifying, and reporting this data.

5.3 Examples

Example projects were used to demonstrate the pollutant load reductions for protocols 1, 2, 3, and 4. Practices must meet the criteria for the basic qualifying conditions to receive TMDL pollutant load reduction. Basic qualifying condition decision tree examples are provided. It was assumed that for Protocol 1, site assessments indicated there were no SAV beds in the vicinity of these projects as required by Step 1 but there was no verification if this was the case.

The remaining examples in *Section 5.3.2 Maryland Example* and *Section 5.3.3 Virginia Example*, assume that the basic qualifying conditions were met. This means that after meeting the basic qualifying conditions, the Chesapeake Bay TMDL pollutant load reductions were allowed and were calculated using the protocols. In addition, the examples in *Section 5.3.2 Maryland Example* and *Section 5.3.3.1 Virginia Example -1* assume that the default values were used for bulk density. In addition, these examples assume that the reporting agency did not receive acceptable bank stability report (*see Section 5.2.1.1 Sand and Bank Instability Reductions for Prevented Sediment for more information*). However, example in *Section 5.3.3.2 Virginia Example -2* provided acceptable bank stability reports. Finally, these examples were provided from sites and panelists in Maryland and Virginia.

5.3.1 Basic Qualifying Conditions Examples

Projects must meet the basic qualifying conditions (Table 12) to receive Chesapeake Bay TMDL pollutant load reductions.

Table 12. Basic Qualifying Condition examples.

Site Conditions	Meets Criteria for TMDL Pollutant Load Reduction?	Notes
Example 1. The property owner will build a bulkhead. The site currently has no shoreline management practice and is 50 feet long. The site has active erosion and is in an area where living shoreline could be possible. The project may possibly impact adjacent marsh fringe habitat and does not cover nearshore habitats.	No	• Living shoreline is possible but not implemented • State Agency decides not to issue TMDL credit for this site because of the potential impact to adjacent fringe wetland
Example 2. The property owner requests a living shoreline practice to replace 50 feet of bulkhead. The project area has active erosion. The project regraded and revegetated the bank.	Yes	• Bulkhead is replaced by living shoreline practice
Example 3. A port facility will build a 50 foot bulkhead in an area with tidal shoreline erosion. No living shoreline is possible due to site constraints; the nearshore water is too deep. The tidal erosion is contributing toxics to the water.	Yes	• Site is experiencing shoreline erosion • Site is a port facility where no living shoreline, breakwater, or revetment can be constructed
Example 4. A 50 foot bulkhead is failing and a 50 foot bulkhead will be constructed. The project area is experiencing shoreline erosion. The practice will negatively impact marsh fringe habitat. Other practices such as a	No	• Alternative practices with less, or no adverse habitat impacts could be implemented • State agency decides not to issue credit because of impact to fringe
Site Conditions	**Meets Criteria for TMDL Pollutant Load Reduction?**	**Notes**
breakwater or revetment without living shoreline could be implemented.		marsh.habitat and other options were available.

Example 5. A 50 foot living shoreline will be constructed. The project area is experiencing shoreline erosion. The site will not be regraded. The site will not be revegetated.	No	□ The site will not be regraded and will not be revegetated

5.3.2 Maryland Example

This is the Essex Skypark Living Shoreline Enhancement Project that was conducted by Baltimore, County, Maryland's Department of Environmental Protection and Sustainability through the Capital Program Operations Section. Essex Skypark is located on the Back River community of Essex, MD located in the Back River watershed.

Figure 5. Reach 2 – Location 1 pre-construction.

Figure 6. Reach 5-B Location 1 post-construction.

5.3.2.1 Maryland Example– Pollutant Load Reductions for the Shoreline Management Practice: Living Shorelines with Sills and Breakwaters

Protocol 1 – Prevented Sediment

Three reaches along the Back River shoreline were identified as severely eroded and in need of stabilization (Figure 5). The first reach (reach 2) had a variable 6 to 8 foot high vertical bank along 1,079 feet on the north end of Essex Skypark (Figure 6). The fetch is approximately 2.9 miles and the shoreline is subject to significant wind-generated wave action. Many trees along the shoreline fell. This exposed the clay soils and resulted in bank recession. The second reach (reach 5A) includes a total of 881 linear (LF) and the third reach (reach 5B) includes 650 LF on the south end of the property with a bank height ranging from 3 to 5 feet along the shoreline (Figure 6). The rate of erosion on the north shoreline averaged of 1.5 feet per year and on the south shoreline averaged 1.0 foot per year.

The shoreline management project included structural and non-structural erosion control and shoreline enhancement techniques along 2,610 LF including the creation of a living shoreline planted with 79,513 square feet of wetland grasses that were protected by 12 off shore stone sills and 5 off shore stone breakwaters. Table 13 outlines the protocol 1 Prevented Sediment values.

Table 13. Protocol 1: Prevented sediment calculations for MD Example.

Shoreline Parameter	Length (ft)	Erosion Rate (ft/yr)	Average Bank Height (ft)	Sediment (ft^3/yr)	Sediment[1] (lbs/yr)	Sediment (tons/yr)
Reach 2	1,079	1.5	7	11,329.5	1,060,441	530.2
Reach 5A & 5B	1,531	1.0	4	6,124.0	573,206	286.6
Totals	2,610				1,633,647	
MD Reduction (55.1%)[2]					**900,139**	
50% Bank Instability Reduction[3]					**450,070**	

[1]Soil bulk density – 93.6 lb/ft^3 (p.9)*
[2]Reduction for sediment based on % fines vs sands in MD soils**
[3] MDE decided to impose a 50% reduction factor because of stability concerns
*Ibison, N.A., J.C. Baumer, C.L. Hill, N.H. Berger, J.E. Frye. 1992. Eroding Bank Nutrient Verification Study for the Lower Chesapeake Bay. Department of Conservation and Recreation, Division of Soil and Water Conservation. Gloucester Point, VA.
**Chesapeake Bay shoreline characteristics and shoreline erosion mass loading (averaged) (Halka, 2013).

Protocol 1 total project pollutant load reductions from Table 13:

- Fines (Clay and Silt) = 450,070 lb/yr
- TN = (816,824 lbs/yr TSS)*(0.000290 lb N/lb TSS) = 237 lbs/yr N
- TP = (816,824 lbs/yr TSS)*(0.000205 lb P/lb TSS) = 167 lbs/yr P

Note that the estimated value of the sediment load of clay and silt to the tidal Bay is 450,070 lb/yr with the Maryland sand reduction (55.1%) and the 50% bank stability considered. The sand reduction is done because the sand portion of the total sediment load to tidal waters is considered beneficial and not a detriment to tidal Chesapeake water quality. With the nutrient load reductions, however, only the 50% bank stability decrement is applied to decrement the total tidal shoreline prevented sediment load because the original Ibison et al. (1990; 1992) weight/weight estimates of TN and TP in tidal shoreline sediment were based on total sediment (TSS) including fines and sand. Therefore, to calculate the nutrient content the sediment total of 1,633,647 lbs is decremented only by the 50% Bank Instability Reduction.

Protocol 2 – Denitrification

Vegetated Area: 79,513 square feet of vegetative plantings (1.8 acres) Denitrification rate: 85 lb TN/acre/yr

Area of marsh planting = 1.8 acres
Denitrification pollutant load reduction: 85 lb TN/acre/yr

Protocol 2 total project pollutant load reduction:

- TN = 85 lb TN/acre/yr * 1.8 acres
- **TN = 153 lb/yr**

Protocol 3 - Sedimentation

Vegetated Area: 79,513 square feet of vegetative plantings (1.8 acres)
Sedimentation pollutant load reduction: 5.289 lbs TP/acre/yr and 6,959 lbs TSS/acre/yr

Protocol 3 total project pollutant load reduction:

- TP = 5.29 lbs TP/acre/yr * 1.8 acres
- **TP = 9.52 lbs-TP/yr**

- TSS = 6,959 lbs TSS/acre/yr * 1.8 acres
- **TSS = 12,526 lbs-TSS/yr**

Protocol 4 - Marsh Redfield Ratio

Vegetated Area: 79,513 square feet of vegetative plantings (1.8 acres)
Marsh Redfield Ratio pollutant load reduction: 6.83 lbs TN/acre/yr and 0.3 lbs TP/acre/yr

Protocol 4 total project pollutant load reduction:

- TN = 6.83 lbs TN/acre/yr * 1.8 acres
- **TN = 12.3 lbs-TN/yr**

- TP = 0.3 lbs TP/acre/yr * 1.8 acres
- **TP = 0.54 lbs-TP/yr**

This example's total pollutant load reductions are the sum of Protocol 1, Protocol 2, Protocol 3, and Protocol 4 that are provided in Table 14.

Table 14. Maryland's example total pollutant load reductions.

Pollutant	Protocol 1 Pollutant Load Reduction (lb/yr)	Protocol 2 Pollutant Load Reduction (lb/yr)	Protocol 3 Pollutant Load Reduction (lb/yr)	Protocol 4 Pollutant Load Reduction (lb/yr)	Year 1 Total Pollutant Load Reduction (lb/yr)[1]
TN	237	153	NA	12.3	402
TP	167	NA	9.52	0.54	177
TSS (clay & silt)	450,070	NA	12,526	NA	462,596

[1]This practice was 2,610 linear feet, had an erosion rate of 1 and 1.5 ft/yr, had a bank height of 4 and 7 feet, and had 1.8 acres of vegetation. See other site specifics in the project description.

5.3.3 Virginia Examples

Two Virginia example sites were provided. The Virginia examples include an unnamed Department of Defense (DOD) facility and the City Farm in Newport News, Virginia. These sites both experience erosion and need a shoreline management practice. A breakwater system was proposed at DOD (Figure 7) and a marsh sill was proposed at City Farm (Figure 8 and Figure 9). The breakwater system and living shoreline represent Virginia's examples 1 and 2.

For each site, review the basic qualifying conditions in Section 4 to ensure the project is eligible for Chesapeake Bay TMDL TN, TP, and TSS pollutant load reductions. If the project is eligible, calculate the TN, TP, and TSS pollutant load reductions using Protocols 1, 2, 3, and 4, if applicable. For future projects VA DEQ may require an assessment to determine if any SAV beds could be affected and decide whether credit should be provided toward jurisdictional Bay restoration goals due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

5.3.3.1 Virginia Example 1– Pollutant Load Reductions for the Existing Site Conditions: DOD Breakwater System (Hybrid Design)

Site Characteristics for the DOD Breakwater System (Hybrid Design) The following site characteristics existed at the DOD VA site:

- High bank fastland erosion with small beach at toe

- Between two stable marsh areas that did not have bank erosion landward of the marsh Length = 750 ft
- Example 1 – Proposed breakwater system (Hybrid Design)

Protocol 1 – Prevented Sediment

- The erosion rate of 0.383 ft/yr was obtained from average of VIMS shoreline evolution report data, derived from actual shapefile results and not the published ranges ○ Average bank height (B) = 29 ft
  ○ Volume (V) = 8,330 cf/yr *93.6 lbs./cf (bulk density) = 389.8 tons/yr

- Total Sediment Removal = [389.8 tons/yr (or 779,600 lbs/year)] * [0.337 (VA default sand reduction factor)]
  Sediment Removal of Fines = 131.4 tons/yr or clay and silt fines = 262,755 lb/yr
  Nitrogen Removal = (779,600 lbs/year TSS)*(0.000290 lb N/lb TSS) = 226 lbs/yr N
  Phosphorus Removal = (779,600 lbs/year TS)*(0.000205 lb P/lb TSS) = 160 lbs/yr P

Note that the estimated value of the sediment load to the tidal Bay is 262,755 lb/yr with the Virginia sand reduction (33.7%) considered. The sand reduction is done because the sand portion of the total sediment load is considered beneficial and not a detriment to Chesapeake water quality. With the nutrient load reductions, however, the total tidal shoreline prevented sediment load is used in the calculation because the original Ibison et al. (1990; 1992) weight/weight estimates of TN and TP in tidal shoreline sediment were based on total sediment including fines and sand. Therefore, to calculate the nutrient content of the prevented tidal shoreline loads the sediment total of 389.8 tons/yr or 779,600 lb/yr is used.

Protocol 2 – Denitrification

Area of marsh planting = 0.41 acres
Denitrification pollutant load reduction: 85 lb TN/acre/yr

Protocol 2 total project pollutant load reduction:

- TN = 85 lbs-TN/acre/yr * 0.41 acres
- **TN = 34.9 lbs-TN/yr**

Protocol 3 – Sedimentation

Area of marsh planting = 0.41 acres
Sedimentation pollutant load reduction: 5.289 lbs TP/acre/yr and 6,959 lbs TSS/acre/yr

Protocol 3 total project pollutant load reduction:

- TP = 5.289 lbs-TP/acre/yr * 0.41 acres
- TSS = 6,959 lbs-TSS/yr * 0.41 acres

- **TP = 2.2 lbs-TP/yr**
- **TSS = 2,853 lbs-TSS/yr**

Protocol 4 - Marsh Redfield Ratio

Area of marsh planting = 0.41 acres
Marsh Redfield Ratio pollutant load reduction: 6.83 lbs TN/acre/yr and 0.3 lbs TP/acre/yr

Protocol 4 total project pollutant load reduction:

- TN = 6.83 lbs-TN/acre/yr * 0.41 acres
- TP = 0.3 lbs-TN/acre/yr * 0.41 acres
- **TN = 2.8 lbs-TN/yr**
- **TP = 0.12 lbs-TP/yr**

Virginia example 1 total pollutant load reductions are the sum of Protocol 1, Protocol 2, Protocol 3, and Protocol 4 provided in Table 15.

Table 15. Virginia Example 1 total pollutant load reductions.

Pollutant	Protocol 1 Pollutant Load Reduction (lb/yr)	Protocol 2 Pollutant Load Reduction (lb/yr)	Protocol 3 Pollutant Load Reduction (lb/yr)	Protocol 4 Pollutant Load Reduction (lb/yr)	Year 1 Total Pollutant Load Reduction (lb/yr)[1]
TN	226	34.9	NA	2.8	264
TP	160	NA	2.2	0.12	162
TSS	262,725	NA	2,853	NA	265,608
[1]This practice was 750 linear feet, had an erosion rate of 0.383ft/yr, had a bank height of 29 feet, and had 0.41 acres of vegetation. See other site specifics in the project description.					

5.3.3.2 Virginia Example 2– Pollutant Load Reductions for the Existing Site Conditions: City Farm Living Shoreline (Marsh Sill)

Site Characteristics for the City Farm Living Shoreline (Marsh Sill)

The following site characteristics existed at the City Farm site in Newport News, VA site:

- Low to moderate bank heights
- Located at the mouth of Deep Creek, at its confluence with the James River
- Length = 500 ft
- Example 2 – Proposed Living Shoreline (marsh sill) with bank grading and stabilization

<u>Protocol 1 – Prevented Sediment</u>

- The estimated erosion rate is 1.34 ft/yr. There were no erosion values included in the VIMS shoreline evolution report since it stopped just short of the project site. Therefore, comparable information was derived from aerial imagery comparisons for the same two years as the VIMS study that included 1937 and 2007. o Average bank height (B) = 3 ft *Note 1: There was one isolated area with a higher bank height and the average observed height was used for this 500 ft reach.*
  - V = 2,680 cf/yr
  - Soil bulk density = 93.6 lb/cf (default value)

  Note: No bank instability reduction was used since proper bank grading and vegetation practices were included in the project design. The shoreline management project applicant provided detailed bank stability analysis to the local reporting agency to document that no additional sediment and associated pollutants were expected to enter the nearshore waters and included the following conditions: 1) the project was graded and vegetated so that the bank was stable and 2) excess sediment was removed offsite so that the sediment did not enter the nearshore waters. Bank analysis demonstrated the site had bank stability with minimum risk of erosion. This was coordinated with the local reporting authority to ensure proper methods, reporting, and requirements were fulfilled and were accepted by that authority so that the project met this basic qualifying condition.

- **Sediment Removal** = [125.4 tons/yr (or 250,800 lbs/yr)] * [0.530 (site specific weighted average for percentage of silts/clays obtained during sediment sampling; this value was used instead of the VA default sand reduction factor)] * [100%]

  - **Sediment Removal of Fines** = 66.5 tons/yr or clay and silt fines = 133,000 lb/yr
  - **Nitrogen Removal** = (250,800 lb/yr TSS) (0.000290 lb N/ lb TSS) = 72.7 lbs/yr N
  - **Phosphorus Removal** = (250,800 lb/yr TSS) (0.000205 lb N/lb TSS) = 51.4 lbs/yr P

  Note that the estimated value of the sediment load to the tidal Bay is 262,755 lb/yr with the site specific sand reduction (53.0%) considered. The sand reduction is done because the sand portion of the total sediment load is considered beneficial and not a detriment to Chesapeake water quality. With the nutrient load reductions, however, the total tidal shoreline prevented sediment load is used in the calculation because the original Ibison et al. (1990; 1992) weight/weight estimates of TN and TP in tidal shoreline sediment were based on total sediment including fines and sand. Therefore, to calculate the nutrient content of the prevented tidal shoreline loads the sediment total of 125.4 tons/yr or 250,800 lb/yr is used.

<u>Protocol 2 – Denitrification</u>

Area of marsh planting = 0.21 acres

Denitrification pollutant load reduction: 85 lb TN/acre/yr

Protocol 2 total project pollutant load reduction:

- TN = 85 lbs-TN/acre/yr * 0.21 acres
- **TN = 17.9 lbs-TN/yr**

Protocol 3 – Sedimentation

Area of marsh planting = 0.21 acres
Sedimentation pollutant load reduction: 5.289 lb TP/acre/yr and 6,959 lbs TSS/acre/yr

Protocol 3 total project pollutant load reduction:

- TP = 5.289 lbs-TP/acre/yr * 0.21 acres
- TSS = 6,959 lbs-TSS/acre/yr * 0.21 acres
- **TP = 1.1 lbs-TP/yr**
- **TSS = 1,461 lbs-TSS/yr**

Protocol 4 – Marsh Redfield Ratio

Area of marsh planting = 0.21 acres
Marsh Redfield Ratio pollutant load reduction: 6.83 lbs TN/acre/yr and 0.3 lbs TP/acre/yr

Protocol 4 total project pollutant load reduction:

- TN = 6.83 lbs-TN/acre/yr * 0.21 acres
- TP = 0.3 lbs-TP/acre/yr * 0.21 acres
- **TN = 1.44 lbs-TN/yr**
- **TP = 0.06 lbs-TP/yr**

Virginia Example 2 total pollutant load reductions are the sum of Protocol 1, Protocol 2, Protocol 3, and Protocol 4 provided in Table 16.

Table 16. Virginia Example 2 total pollutant load reductions.

Pollutant	Protocol 1 Pollutant Load Reduction (lb/yr)	Protocol 2 Pollutant Load Reduction (lb/yr)	Protocol 3 Pollutant Load Reduction (lb/yr)	Protocol 4 Pollutant Load Reduction (lb/yr)	Year 1 Total Pollutant Load Reduction (lb/yr)[1]
TN	72.7	17.9	NA	1.44	92.0
TP	51.4	NA	1.1	0.06	52.6
TSS	133,000	NA	1,461	NA	134,461
[1]This practice was 500 linear feet, had an erosion rate of 3 ft/yr, had a bank height of 3 feet, and had 0.21 acres of vegetation. See other site specifics in the project description.					

Figure 7. Virginia DOD site used for Example 1.

Figure 8. Virginia City Farm site (B-1) used for Example 2.

Figure 9. Virginia City Farm site (B-2) used for Example 2.

Section 6. Accountability and Unintended Consequences

Shoreline management practices must be accounted for and verified to maintain the function and therefore the Chesapeake Bay water quality protection that we track as the pollutant load reductions outlined here. The reporting, tracking, and verification parameters are provided.

The Panel recognizes that shoreline management projects as defined in this report may be subject to authorization and associated requirements from federal, State, and local agencies. The recommendations in this report are not intended to supersede any other requirements or standards mandated by other government authorities. Consequently, some shoreline management projects may conflict with other regulatory requirements and may not be suitable or authorized in certain locations. Therefore, close and continued coordination with the federal, State, and local agencies will be necessary.

The panel recognizes that shoreline management practices are an ecosystem trade off and these recommendations were made with science that may be updated (Section 7). The identified unintended consequences are provided.

6.1 Reporting, Tracking, and Verification

Reporting, tracking, and verification are needed to ensure that the shoreline management practices are performing as designed. The CBPO's BMP Verification Review Panel is charged with developing verification recommendations that the States in the Chesapeake Bay Partnership can use to develop specific verification protocols to confirm continual nutrient and sediment reductions from Chesapeake Bay watershed BMPs. The CBPO requires robust protocols for reporting, tracking, and verification to support the TMDL goals.

The panelist's experience and research determined that the local governments may not always report the shoreline management practices to the state and that the state may report the shoreline management practices as urban stream restoration to the EPA CBPO. Currently, there are a variety of systems to report, track, and verify shoreline management practices at the local government level and at the state level. In addition to multiple systems for reporting, tracking, and verifying, the data extent, duration, and quality of data varies. The Panel recommends the following actions to report, track, and verify shoreline management for credit towards the Chesapeake Bay TMDL.

Currently, shoreline projects are reported from local governments to the state agency responsible for tracking progress of the Watershed Implementation Plans and MS4 as using existing conduits/tools to acquire information. The states then report to the CBPO through National Environmental Information Exchange Network (NEIEN). Although jurisdictions may enter shoreline management practices into NEIEN and the supporting CAST, VAST, or MAST, the CBPO has no record of these projects reported. The NEIEN BMP reporting guidance should be updated to ensure that this practice is correctly reported in NEIEN.

6.1.1 Units for Local Government to Report to State

The local governments should report shoreline management projects to the state based on the state's standard reporting practices. The reporting parameters are provided in Table 17.

The default values will be used in the EPA CBPO modeling tools. The technical requirements for entering the shoreline management practice into Scenario Builder are provided in Appendix C.

Additional data gathered to meet basic qualifying conditions and/or to take the place of default values in the protocols must be thoroughly vetted prior to data collection and fully accepted by the permitting and reporting agency. This ensures that the best practices and best information from these practices are used and reported. For example, the site specific data, such as bank stability information, should be vetted with the permitting and reporting agency. Another example includes, the site specific monitoring data used to calculate and report TN, TP, and/or TSS pollutant load reductions for protocols 1 through 4 should be vetted with the permitting and reporting agency. The default values provided represent the best available information at the time and site specific sampling can provide more accurate pollutant load reduction values for that site. All site specific data must be fully vetted with the permitting and reporting agency to ensure that the information is allowed for Chesapeake Bay TMDL pollutant load reduction credits.

In cases when the shoreline management practice parameters are unavailable for the protocols recommended by the panel, such as in some planning efforts, historic projects, and/or nonconforming projects, then a default reduction value can be used. The default sediment values are 164 lbs/lf/yr in (MD) or 42 lbs/lf/yr, which were based on the fine sediment erosion rates in Table 3 converted to total sediment including sand because the original nutrient observation were based on a wt/wt percent metric of nitrogen and phosphorus nutrients in total sediment. The default nutrient reduction values depend which state the project is located in. For MD/DC/DE projects, the default value for nitrogen is 0.04756 lbs/lf/yr, whereas for phosphorus it is 0.03362 lbs/lf/yr. For VA projects, the default value for nitrogen is 0.01218 lbs/lf/yr, whereas for phosphorus it is 0.00861 lbs/lf/yr.

Table 17. Units for local governments to report to state.

Protocol	Parameters to Report	Notes
All Protocols	• Practice type • Year installed • Location coordinates • USGS HUC and/or latitude and longitude at the project center to identify where project is located • Land use(s) • If applicable, acres treated by practice	• All reporting should be coordinated with the local and state permitting and reporting authority to ensure compliance • General reporting requirements for all projects should be followed

Protocol	Parameters to Report	Notes
Protocol 1. Prevented Sediment	• Length (ft) • Height of project (ft) • Erosion rate (ft/yr)	If values other than default values are used, these calculations should be reported to the reporting entities specification (e.g., TN, TP, and TSS for sites with site specific sampling data) Records should be kept and available for inspection to relay the data source, calculations made, and other data reported to the state
Protocol 2. Denitrification	Vegetation surface area (acre) ○ Net increase of vegetation	
Protocol 3. Sedimentation	Vegetation surface area (acre) ○ Net increase of vegetation	
Protocol 4. Marsh Redfield Ratio	Vegetation surface area (acre) ○ Net increase of vegetation	

6.1.2 Expected Values

The expected values for TN, TP, and TSS pollutant load reduction will vary based on the following factors:

- Site erosion rate
- Practice length and bank height
- Site specific nutrient values sampled or default values used
- Practice vegetative area

However, the examples provided in Section 5.3 for Maryland and Virginia provide a general framework for the potential TN, TP, and TSS pollutant load reduction values using the protocols provided in this report and the example site conditions.

6.1.3 Tracking

State agencies currently track shoreline management projects using their own databases. In Maryland, MDE collects and tracks the project information to include the tracking number, permit number, effective start date (date of authorization), project type, county, practice type, activity code, and national wetlands inventory (NWI) code. For marsh projects the name, tracking number, permit number, county, latitude, longitude, watershed, hydrologic unit code (HUC) 8-Digit, marsh type, effective start date, length, width, square feet, and acreage are collected and tracked.

If the project is a living shoreline the surface area in square feet is also recorded. In Virginia, a tracking number is generated when VMRC receives the permit application for each project. Recently, the VMRC developed a habitat management permit tracking system that includes shoreline management projects. The database includes several parameters such as the tracking number, applicant, locality, waterway, practice type, and linear feet of the project.

6.1.4 Verification

Verification is required for practices to ensure the practice is installed as designed, is maintained, and functions as designed over time. The verification guidance serves to create a record for the responsible party to document and record the practice meets or exceeds benchmarks in the field, recordkeeping, and reporting needed for the pollutant load reduction received. Finally, verification principles outline the evaluation and re-evaluation criteria, timeframe, and process. The verification principles outlined here should support local, state, and federal requirements. Finally, the verification process includes guidance for nonconforming project evaluation.

6.1.4.1 Initial Performance Verification

Initial performance verification involves the responsible crediting party providing post-construction documentation to the reporting agency (local government or state agency). This certification should demonstrate that the project was installed properly and meets or exceeds the restoration objectives. If vegetation was present, the certification should demonstrate the vegetation is stable and has acceptable vegetation coverage. Stable vegetation thresholds should be defined and consistently used by the responsible party. For example, the threshold for the City of Norfolk, Virginia is 85% vegetation coverage at the site. Initial verification is provided either by the designer, local inspector, or state permit authority as a condition of project acceptance or final permit approval. Initial verification should be done prior to submitting the load reduction to the state tracking database.

6.1.4.2 Duration of Shoreline Management Credit

The shoreline management pollutant load reduction credit is for five years which can then be reevaluated using local inspection, verification, and reporting protocols.

6.1.4.3 Reporting to the State

The agency that seeks credit for the practice must submit basic documentation to the appropriate state agency to document the nutrient and sediment reduction reported for each individual shoreline management project installed. Localities should check with their state agency for the specific data to report for individual projects.

6.1.4.4 Record Keeping

The crediting agency should maintain an extensive project file for each shoreline management project installed (e.g., construction drawings, credit calculations, digital photos, post construction monitoring, inspection records, and maintenance agreement). The file should be maintained for the lifetime for which the load reduction will be claimed.

6.1.4.5 Future Field Verification to Ensure Project Performance

The crediting agency should conduct inspections once every five years to ensure that individual projects are still capable of removing nutrients and sediments. The crediting agency is the entity doing or overseeing the implementation, such as local governments. States should develop performance standards to determine that projects are functioning as designed.

6.1.4.6 Previously Installed Project and/or Non-Conforming Projects

Past projects and projects that do not conform to these reporting requirements, can receive credit using the default rate discussed in Section 3.4. The new protocols can be applied to projects that were installed less than 5 years from this expert panel report's acceptance at the CBPO to receive credit. However, the credit determined from the new protocols must then be used, regardless of whether it is higher or lower than the credit provided by the old rate.

6.1.4.7 Down-Grading

If a field inspection indicates that a project is not performing to its original specifications, the locality has up to one year to take corrective maintenance or rehabilitation actions to bring it back into compliance. If the facility is not fixed after one year, the pollutant reduction for the project would be eliminated, and the locality would report this to the state in its annual MS4 report or WIP progress updates. If the locality is not an MS4 community or is a non-permitted municipality, they are expected to submit annual progress reports. Finally, the load reduction can be renewed if evidence is provided that corrective actions were performed that restored the practice performance.

6.2 Unintended Consequences

The basic qualifying conditions (Table 7) are critical for reducing unintended consequences. These conditions provide criteria for the site and project conditions under which nitrogen, phosphorous, and sediment load reductions should or should not be provided to a project. Generally, projects can earn credit only if they are implemented at sites at which active erosion can be demonstrated, and credit for armor can only be obtained at sites in which "softer" approaches (living shorelines) are demonstrated to be infeasible or at sites such as port facilities, marine industrial facilities, or other marine commercial area.

Ideally, the implementation of shoreline management practices is to improve water quality and ecological conditions. However, it is recognized by the panel that this may not always be the case. The shoreline zone of the Chesapeake is host to many different habitat types such as emergent wetland, SAV, oyster reef, coarse woody debris, mudflat, etc., many of which themselves are known to host higher macrofaunal species densities and diversities than armored shoreline erosion control devices. Two of these habitats, oyster and SAV both, are currently managed by the Chesapeake Bay Program Office with the goal to achieve higher levels of distribution. Additionally, specific minimum SAV acreage requirements have been established to remove a water body from the 303d list of impairments for water clarity.

Installation of erosion control devices can be at the expense of these other habitat types. As an example, studies show that reduction in erosion in some cases can negatively impact SAV, and that SAV densities are highest in areas of mid-range erosion rates (Palinkas and Koch, 2012). Therefore, to avoid encouragement of adverse impacts on SAV, the Expert Panel recommended that for Protocol 1, local and state agencies should not issue credit toward jurisdictional Bay restoration goals in areas where SAV is already present due to the negative impact of shoreline erosion control practices on SAV.

Further, jurisdictions and state agencies may choose not to provide credit when other natural resources are adversely affected by the use shoreline management practices. However, the WQGIT while agreeing with the concerns of the Expert Panel felt that these recommendations were too restrictive and instead recommends that local jurisdictions and states be given the flexibility on a case by case basis on whether a credit should be issued or not which applies to all of the protocols. There are overlaps with the practice in areas such as marsh vegetation plantings that serve another benefit for areas without active erosion. The panel anticipates areas of overlap such as this will be addressed in future panels. In addition, credits should not be provided when another natural resource is adversely impacted.

The use of SAV thresholds as a qualifying condition was considered but not recommend by the panel at this time. SAV is a Chesapeake Bay goal and is to protect habitat. However, the current state of the science did not warrant a basic qualifying condition at this time. SAV research needs were identified to inform future updates and recommendations to this report (Section 7).

An unintended consequence for shoreline management occurs when practices are installed because of the relatively high pollutant load reduction credits in poorly selected sites or where they are not needed. However, jurisdictional approvals and the permitting process would likely minimize these unintended consequences. Shoreline protection structures are justified only if there is active, detrimental shoreline erosion which cannot be otherwise controlled; if there is rapid sedimentation adversely impacting marine life or impairing navigation which cannot be corrected by upland modifications; or if there is a clear and definite need to accrete beaches.

A watershed management approach should be used to identify and use appropriate BMPs in the watershed prior to the shoreline whenever possible. In addition, the comprehensive approach to shoreline management can support better shoreline management practice implementation to meet Chesapeake Bay goals (see Appendix D).

Shoreline management practices should be properly located on the site, should include the proper BMP type for that site. The local policy and permitting authority can guide these decisions. For example, Maryland is updating the structural shoreline stabilization maps that will be used for guidance. These maps provide guidance for areas designated as appropriate for structural shoreline stabilization measures. MDE is the agency responsible for the development and maintenance of the maps.

Each shoreline management project should be assessed based on the guidance provided by the local permitting authority, the best professional judgment of experts in the field, and can be supported by the principles and benchmarks presented in this document (Appendix G).

Section 7. Future Research and Management Needs

The Panel included experts in the field and as part of its work intensively reviewed relevant research to provide the recommendations in this report. However, the available information used to make management decisions is compiled and summarized to make broad management decisions, is often incomplete, and often superseded when new information is gathered. The Panel recognizes these limitations and provides the following recommendations for future management and research needs. These recommendations provide guiding principles to advance shoreline management in the future.

7.1 Panel's Confidence in Recommendations

One of the key requirements of the BMP Review Protocol is for the Expert Panel to assign its degree of confidence in the removal rates that it ultimately recommends (WQGIT, 2010). While the Panel considers this report's current recommendations are an improvement to the previously approved CBPO removal rates, the Panel clearly acknowledges that scientific gaps exist to our understanding for shoreline management. Examples of information gaps that point to research needs included:

- Site specific shoreline management erosion rates and associated estimates of TSS, TN and TP loads;
- Information on shoreline management type and its associated effectiveness to protect the nearshore water quality (i.e., prevent sediment and associated TN and TP loads); and
- Shoreline management type and the associated habitat protection and restoration.

The Panel worked to reach consensus for the management recommendations included in this report. However, the Panel included a minority dissenting view for the following recommendations: 1) allow pollutant load reduction for hard shore armor; and 2) allow pollutant load reduction for sandy sediments. See Appendix L for the panel's dissenting views. Based on the available information, Expert Panel expertise, and outlined panel process these decision points were vetted with the panel members, voted on, and this report contains the recommendations reached through the panel process (see *Section 1.2 Panel Process*; WQGIT, 2010; WQGIT, 2012).

7.1.1 Proposed Timeframe for Panel Recommendations Review and Update

The panel proposes that the report findings should be updated at least every two years to include new information. The new information can come from additional research, implementation lessons learned, and/or CBPO workgroups and goal implementation teams.

7.2 Proposed Refinements in Next Phase of the CBWM and/or the WQSTM

Implementation of the sediment and nutrient load reductions from shoreline management actions will be operationally accomplished through aggregation of the shoreline management practices through Scenario Builder. The decrease in nutrient and sediment loads will be accomplished through an appropriate decrement of the sediment and nutrient loads from watershed land-river segments adjacent to the tidal waters simulated by the WQSTM (Figure 10). Location of the shoreline management action by latitude and longitude, if available, will correctly place the shoreline management action in the correct land-river segments. Refinements will be proposed in the next phase of the CBWM and/or the WQSTM to accomplish better simulation for the land-river segments adjacent to tidal waters.

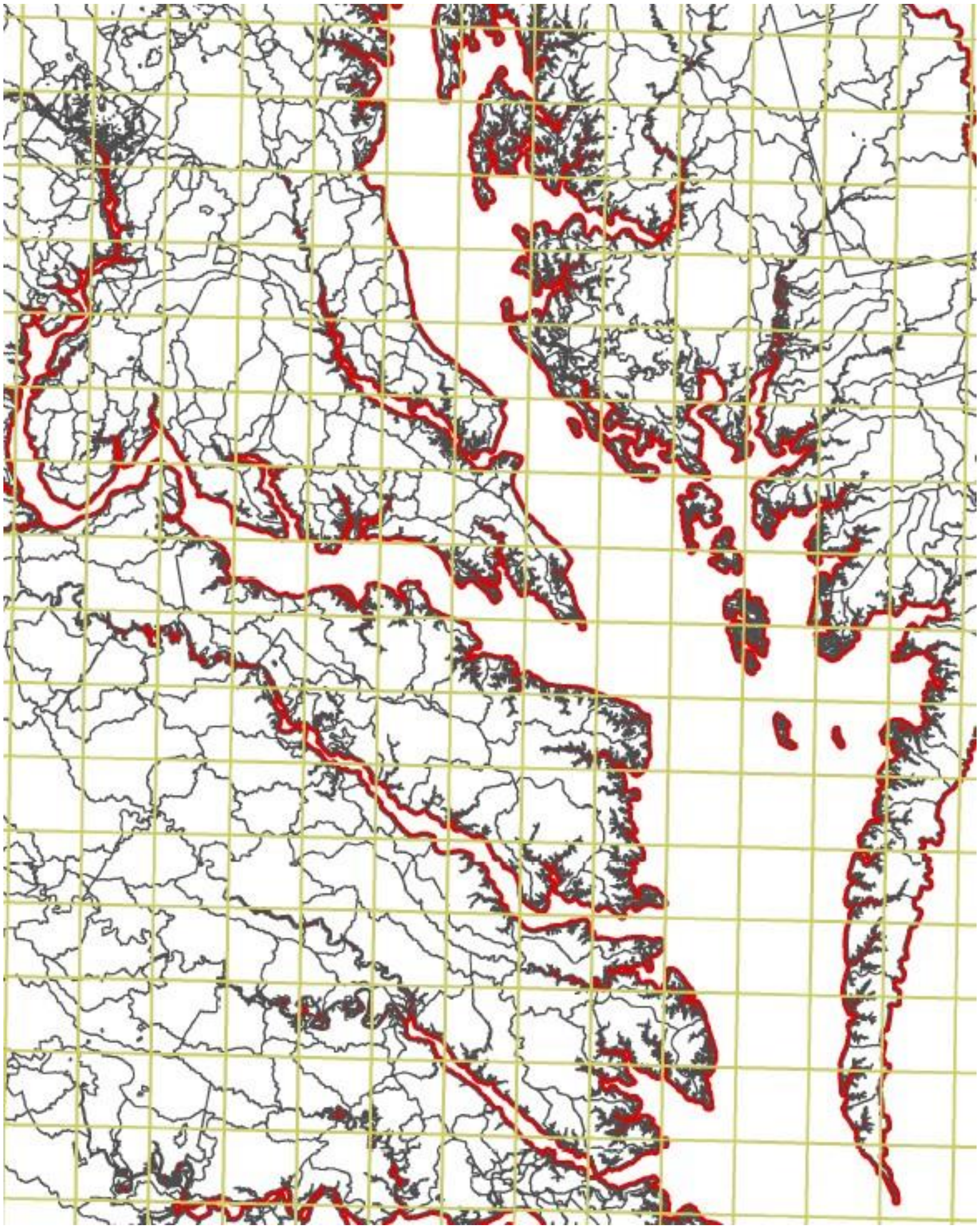


Figure 10. Watershed Model land-river segments shown in black and adjacent tidal waters are outlined in bold red.

7.3 High Priority Management and Research Recommendations

The Panel recognized that the Panel report's recommendations were based on the best available information. This synthesis of the available information and discussion in the Expert Panel process led to a list of high priority management and research recommendations. These research recommendations are not exhaustive and should be added to as more data needs, information needs, and/or policy needs are recognized.

Table 18 outlines the management and research recommendations and their rationale. There is a need to conduct, review, and synthesis new findings so that the shoreline management practices are represented to the best extent possible in the models and on the ground. This research should be used to update this panel recommendations included in this report.

Table 18. High priority management and research recommendations.

Research Recommendation	Rationale
• Update the shoreline erosion rates so that the states have a complete dataset	A complete shoreline erosion rate that is up-to-date is needed to calculate the prevented sediment. The reported shoreline erosion data and modeling is based on the best available information. However, there are data limitations that include but are not limited to the following: 1) the reported total sediment loading from shoreline erosion from Cerco et al. (2010) was approximately half the value reported from Langland and Cronin (2003); 2) shoreline areas of limited or no data exist.
• Research the nearshore sediment erosion and associated nutrient pollutant load	There is a need to account for the nearshore erosion to better estimate the practice’s prevented sediment. Study recommendations include using updated erosion rates and adding 0.5 meters to upland bank height for future 2050 estimates of shoreline erosion loads as the percentage of sediment load and re-calculate the contribution of bank and nearshore sediment loading (Hardaway et al., 2009). The addition of 0.5 meters to the upland bank height when estimating future loads from shoreline erosion is based on the best estimate of relative sea level rise by 2050 in the Chesapeake (Boesch et al., 2013).
• Identify SAV habitat basic qualifying condition criteria • Identify additional habitat basic qualifying condition	There is a need to research and identify SAV habitat where future growth can be supported, report shoreline erosion control structure impacts to SAV, and develop policy recommendations based on these findings. Also, habitat research, the associated basic qualifying conditions, and the resulting policy recommendations are needed. This
Research Recommendation	**Rationale**

	research can inform the Chesapeake Bay TMDL pollutant load reduction basic qualifying condition criteria that promote SAV and other nearshore habitat. (see Section 4.1.3 for further discussion) Note: A large body of research examining the impact of shoreline types, including shoreline erosion control structures, on SAV and other habitats and species will be available for the next expert panel's consideration (i.e., in two years).
• Gather more site specific TN, TP, and TSS bulk density data, bank stability, and sand content • Develop bank sand content thresholds for habitat protection and for CB TMDL pollutant load reductions	There is a need to use site specific sediment, nutrients, and bulk density data instead of the default values from published literature. Also, there is a need to use site specific bank stability and sand content values. This updated site specific data can support better local and default pollutant load reductions. Finally, banks with high sand content contribute to nearshore habitat. A bank sand content threshold is needed to guide CB TMDL pollutant load reduction as an incentive or disincentive to protect habitat that would benefit from that bank sand.
• Research and refine the fines (silt/clay), organic, and sand component of the shoreline • Refine the pollutant load reduction and/or appropriate model to incorporate refined fines, organic, and sand findings	There is a need to recognize and quantify the shoreline sediments. The sediment components (e.g., fines (silt/clay), organic, and sand) correlate with the TN and TP pollutant load. In addition, sand can benefit the nearshore habitat; therefore, sand may not be a pollutant and can benefit the nearshore habitat/water quality.
Update guidance for the following site evaluation parameters: o Map appropriate areas for shoreline management practices o Design considerations o Selecting shoreline management practices o Marsh planting, sills, marsh toe revetments, and breakwaters o Level of protection, encroachment, costs, and permits o Case studies provided for each strategy that discuss the site setting, design elements, and performance o Develop and include design examples to facilitate the design process	There is a need to provide updated guidance for site evaluations that include map parameters and site parameters to better guide practice selection and placement (see also Hardaway et al., 2009).
Research Recommendation	**Rationale**

Research new shoreline management practices (e.g., oyster reefs) and recommend TN, TP, and TSS pollutant load reductions	There is a need to keep up with the evolving science for new shoreline management practices to include researching the pollutant removal, maintenance, lifespan, and other parameters
Monitor shoreline management practice efficiency, maintenance consideration, and lifespan	There is a need to monitor the shoreline management practices to better refine the pollutant load reductions based on updated efficiency, maintenance considerations, and lifespan.
Improve sea level rise estimates	Sea level rise impacts are not considered in the WQSTM and represent an additional research need.
• Revisit the shoreline management information and update the panel report • Recommend a two year panel reassessment period	There is a need to use adaptive management that reviews existing information and new information to update the panel report recommendations. These high priority research recommendations provide better information for models, for local planning, for water quality, and for habitat in the Chesapeake Bay.

References

Anisfeld, S.C., M.J. Tobin, G. Benoit. 1999. Sedimentation rates in flow-restricted and restored salt marshes in Long Island Sound. Estuaries. 22:321-244.

Bänziger, R. 1995. A comparative study of the zoobenthos of 8 land–water interfaces (Lake of Geneva). Hydrobiologia, 301, 133–140.

Berman, M.R., H. Berquist, S. Dewing, J. Glover, C.H. Hershner, T. Rudnicky, D.E. Schatt, and K. Skunda. 2000. Mathews County Shoreline Situation Report, Special Report in Applied Marine Science and Ocean Engineering No. 364, Comprehensive Coastal Inventory Program, Virginia Institute of Marine Science, College of William and Mary, Virginia.

Bilkovic, D.M. and, M. M. Roggero. 2008. Effects of coastal development on nearshore estuarine nekton communities. Marine Ecology Progress Series 358: 27–39.

Bilkovic, D.M., M. Roggero, C.H. Hershner, K. Havens. 2006. Influence of land use on macrobenthic communities in nearshore estuarine habitats. Estuaries and Coasts 29(6B): 1185–1195.

Boesch, D.F., L.P. Atkinson, W.C. Boicourt, J.D. Boon, D.R. Cahoon, R.A. Dalrymple, T. Ezer, B.P. Horton, Z.P. Johnson, R.E. Kopp, M. Li, R.H. Moss, A. Parris, C.K. Sommerfield. 2013. Updating Maryland's Sea-level Rise Projections. Special Report of the Scientific and Technical Working Group to the Maryland Climate Change Commission, 22 pp. June 2013. University of Maryland Center for Environmental Science, Cambridge, MD.

Boon, John D. 2012. Evidence of sea level acceleratio nat U.S. and Canadian tide stations, Atlantic Coast, North America. Journal of Coastal Research 28(6): 1437-1445.

Boynton, W.R., J.D. Hagy, J.C. Cornwell, W.M. Kemp, S.M. Greene, M.S. Owens, J.E. Baker, and R.K. Larsen. 2008. Nutrient budgets and management actions in the Patuxent River estuary, Maryland. Estuaries and Coasts 31: 623-651.

Brauns, M,, X.F. Garcia, N Walz, M.T. Pusch. 2007. Effects of human shoreline development on littoral macroinvertebrates in lowland lakes. Journal of Applied Ecology 44, 1138–1144.

Bryne, Robert J. and Gary L. Anderson. 1977. Shoreline erosion in tidewater Virginia. Science and Ocean Engineering Number 111 of the Virginia Institute of Marine Science. Gloucester Point, Virginia.

Bulleri F. and M.G. Chapman. 2004. Intertidal assemblages on artificial and natural habitats in marinas on the north-west coast of ItalyMarine Biology 145: 381–391.

Callaway, J.C., E.L. Borgnis, R.E. Turner, and C.S. Milan. 2012. Wetland sediment accumulation at Corte Madera Marsh and Muzzi Marsh. Prepared for: San Francisco Bay Conservation and Development Commission.
Cavatorta, J.R., M. Johnson, C. Hopkinson, and V. Valentine. 2003. Patterns of sedimentation in a salt marsh-dominated estuary. Biol. Bull. 205:239-241.

Cerco, Carl F., Sung-Chan Kim, and Mark R. Noel. 2013. Management modeling of suspended solids in the Chesapeake Bay, USA. Estuarine, Coastal and Shelf Science 116: 87-98.

Cerco, Carl F., Sung-Chan Kim, and Mark R. Noel. 2010. The 2010 Chesapeake Bay Eutrophication Model: A report to the US EPA CBPO and to the USACE Baltimore District. US ACE and Development Center. Vicksburg, MS.

Cerco, Carl F. and Mark R. Noel. 2019. The 2017 Chesapeake Bay Water Quality and Sediment Transport Model. U.S. EPA Chesapeake Bay Program Office. Annapolis, MD.

Chen, S., R. Torres, M. Bizimis, and E.F. Wirth. 2012. Salt marsh sediment and metal fluxes in response to rainfall. Limnology and Oceanography: Fluids and Environments. 2:54-66.

Chesapeake Bay Foundation (CBF). 2007. Living shorelines for the Chesapeake Bay watershed. CBF. Annapolis, Maryland.

Chesapeake Bay Program (CBP). 2012. Estimates of county-level nitrogen and phosphorus data for use in modeling pollutant reduction. Documentation for Scenario Builder version 2.4. US EPA CBPO. Annapolis, Maryland.

CBP. 2006. Best Management Practices for Sediment Control and Water Clarity Enhancement. Chesapeake Bay Program. Chesapeake Bay Program. Annapolis, MD.

CBP. 2005. Sediment in the Chesapeake Bay and Management Issues: Tidal Erosion Processes. CBP Nutrient Subcommittee's Tidal Sediment Task Force of the Sediment Workgroup. Chesapeake Bay Program. Annapolis, MD.

Chmura, G.L. 2011. What do we need to assess the sustainability of the tidal salt marsh carbon sink? Ocean and Coastal Management. *In press*.

Chmura, G.L., L.L. Helmer, C.B. Beecher, and E.M. Sunderland. 2001. Historical rates of salt marsh accretion on the outer Bay of Fundy. Can. J. Earth Sci. 38:1081-1092.

Christiansen, T., P.L. Wiberg and T.G. Milligan. 2000. Flow and sediment transport on a tidal salt marsh surface. Estuarine, Coastal and Shelf Science 50: 315-331.

Clark, Inga, Curtis E. Larsen, and Martha Herzog. 2004. Evolution of Equilibrium Slopes at Calvert Cliffs, Maryland: A Method of Estimating the Timescale of Slope Stabilization: Shore & Beach, v. 72, p. 17-23.

Corbett, D.R., D. Vance, E. Letrick, D. Mallinson, and S. Culver. 2007. Decadal-scale sediment dynamics and environmental change in the Albemarle estuarine system, North Carolina. Estuarine, Coastal and Shelf Science 7:717-729.

Cornwell, J.C., J.M. Stribling, J.C. Stevenson. 1994. Biogeochemical studies at the Monie Bay National Estuarine Research Reserve. Organziing for the Coast: Thirteenth International Conference of the Coastal Society. Washington, DC.

Craft, Christopher, Patrick Megonigal, Stephen Broome, Jan Stevenson, Robert Freese, Jeff Cornell, Lei Zheng, and John Sacco. 2003. The pace of ecosystem development on constructed *Spartina Alternifora* marshes. Ecological Applications 13(5): 1417-1432.

Currin, C.A.**,** W.S. Chappell and A. Deaton. 2010**.** Developing alternative shoreline armoring strategies: The living shoreline approach in North Carolina, in Shipman, H., Dethier, M.N.

Currin, C.A., P.C. Delano, and L.M. Valdes-Weaver. 2008. Utilization of a citizen monitoring protocol to assess the structure and function of natural and stabilized fringing salt marshes in North Carolina. Wetlands Ecol. Manage. 16:97-118.

Dahl, T.E. 2011. Status and trends of wetlands in the conterminous United States 2004 to 2009. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C**.**

Davis, JLD, R Schnabel, and R Takacs. 2008. Evaluating ecological impacts of living shorelines and shoreline habitat elements: An example from the upper western Chesapeake Bay. *In* S. Erdle, JLD Davis, and KG Sellner (eds.). Management, Policy, Science and Engineering of Nonstructural Erosion Control in the Chesapeake Bay: Proceedings of the 2006 Living Shoreline Summit, CRC Publ. No. 08-164.

Davis, Jana L.D., Richard L. Takacs, and Robert Schnabel. 2006. Evaluating ecological impacts of living shorelines and shoreline habitat elements: An example from the upper western Chesapeake Bay. *In* S. Erdle, JLD Davis, and KG Sellner (eds). Proceedings of the 2006 Living Shoreline Summit: Management, Policy, Science and Engineering of Nonstructural Erosion Control in the Chesapeake Bay. CRC Publication Number 08-164.

Davis, J., B. Nowicki, and C. Wigand. 2004. Denitrification of fringing salt marshes of Narragansett Bay, Rhode Island, USA. Wetlands 24(4): 870–878.

Davis, J.L.D., L.A. Levin, and S.M.Walther. 2002. Artificial armored shorelines: sites for opencoast species in a southern California bay. Mar. Biol. 140: 1249-1262.

DeLuca, W.V., C.E. Studds, L.L. Rockwood, and P.P. Marra. 2004. Influence of land use on the integrity of marsh bird communities of the Chesapeake Bay, USA. Wetlands 24: 837–847

Duhring, Karen. 2004. Annual Summary of Permitted Tidal Wetland Impacts - 2003. The Virginia Wetlands Report. Virginia Institute of Marine Science, College of William and Mary, Gloucester Pt., VA. Spring 2004 Vol. 19, No.1. http://ccrm.vims.edu/publications/publications_topics/vwr/VWR2004Spring.pdf

Fagherazzi, S., W.L. Wiberg, S. Temmerman, E. Struyf, Y. Zhao, and P.A. Raymond. 2013. Fluxes of water, sediments, and biogeochemical compounds in salt marshes. Ecological Processes 2:1-16.

Findlay, S.E.G., S. Dye, and K.A. Kuehn. 2002. Microbial growth and nitrogen retention in litter of *Phragmites australis* compared to *Typha angustifolia*. Wetlands 22:616–625.

Forand, Nathan. 2013. Presentation to the Shoreline Erosion Control Panel on 3/25/13. Personal communication.

Glick, Patty, Jonathan Clough, and Brad Nunley. 2008. Sea-level rise and coastal habitats in the Chesapeake Bay Region. National Wildlife Federation.

Greene, S.E. 2005. Nutrient removal by tidal fresh and oligohaline marshes in the Chesapeake Bay tributary. M.S. University of Maryland Center for Environmental Science Chesapeake Biological Laboratory. College Park, MD.

Groffman, Peter M. and Marshall Kamau Crawford. 2002. Denitrification in urban riparian zones. Journal of Environmental Quality 32(3): 1144-1149.

Halka, Jeff. 2013, Presentation to the Expert Panel on tidal shoreline erosion rates.

Hardaway, Scott. 2013. Presentation to the Shoreline Erosion Control Panel on 7/16/13. Personal communication.

Hardaway, C. Scott, Jr., Donna A. Milligan, Lyle M. Varnell, and Julie Herman. 2009. Tidal sediment yield estimate methodology in Virginia for the Chesapeake Bay Program Water Quality Model. Virginia Institute of Marine Science. The College of William and Mary. Gloucester Point, VA.

Hardaway, C.S. and R.J. Byrne. 1999. Shoreline management in the Chesapeake Bay. Virginia Institute of Marine Science. Virginia Sea Grant publication VSG-99-11. The College of William and Mary. Gloucester Point, VA.

Hardaway, C.S., G.R. Thomas, J.B. Glover, J.B. Smithson, M.R. Berman, and A K. Kenne. 1992. Bank erosion study. School of Marine Science. Virginia Institute of Marine Science. The College of William and Mary. Gloucester Point, VA.

Hendon, J.R., M.S. Peterson, and B.H. Comyns. 2000. Spatio-temporal distribution of larval Gobiosoma bosc in waters adjacent to natural and altered marsh-edge habitats of Mississippi coastal waters. Bull. Mar. Sci. 66: 143–156.

Hobbs, Carl H. III, Dennis W. Owen, and Lynne C. Morgan. 1979. Summary of shoreline situation reports for Virginia's tidewater localities. Virginia Institute of Marine Science. Gloucester Point, Virginia.

Hopkins, Kate and Jeffery P. Halka, 2007. Developing Shoreline Sediment Erosion Estimates for the Chesapeake Bay. CERF 2007. Providence, RI.

Hopfensperger, K.N., S.S. Kaushal, S.E.G. Findlay, and J.C. Cornwell. 2009. Influence of plant communities on denitrification in a tidal freshwater marsh of the Potomac River, United States. Journal of Environmental Quality 36: 618-626.

Ibison, N. A., J. C. Baumer, C. L. Hill, N. H. Burger, and J. E. Frye. 1992. Eroding bank nutrient verification study for the Lower Chesapeake Bay. Department of Conservation and Recreation. Division if Soil and Water Conservation. Shoreline Programs Bureau. Gloucester Point, Virginia.

Ibison, N. A., C.W. Frye, J.E. Frye, C.L. Hill, and N.H. Burger. 1990. Sediment and nutrient contributions of selected eroding banks of the Chesapeake Bay estuarine system. Department of Conservation and Recreation. Division if Soil and Water Conservation. Shoreline Programs Bureau. Gloucester Point, Virginia.

Jennings M.J., M.A. Bozek, G.R. Hatzenbeler, E.E. Emmons, and M.D. Staggs. 1999. Cumulative effects of incremental shoreline habitat modification on fish assemblages in north temperate lakes. North American Journal of Fisheries Management 19: 18–27.

Johnson, Zoe. 2000. Sea level rise response strategy for the state of Maryland. Maryland Department of Natural Resources, Annapolis, MD.

Jordan, T.E. and D.L. Correll. 1991. Continuous automated sampling of tidal exchanges of nutrients by brackish marshes. Estuarine, Coastal and Shelf Science 32: 527-545.

Jordan, T.E., D.L. Correll, J. Miklas, and D.E. Weller. 1991. Nutrients and chlorophyll at the interface of a watershed and an estuary. Limnology and Oceanography 36(2): 251-267.

Jordan, T.E., J.W. Pierce and D.L. Correll. 1986. Flux of particulate matter in the tidal marshes and subtidal shallows of the Rhode River estuary. Estuaries 9: 310-319.

Jordan, T.E., D.L. Correll and D.F. Whigham. 1983. Nutrient flux in the Rhode River: Tidal exchange of nutrients by brackish marshes. Estuarine Coastal Shelf Science 17: 651-667.

Kana, T.M., M.B. Sullivan, J.C. Cornwell, and K.M. Groxzkowksi. 1998. Denitrification in estuarine sediments determined by membrane mass spectrometry. Limnology and Oceanography 43: 334-339.

Karrh, L., S. VanRyswick, and J. Halka. 2011. Improving site selection for submerged aquatic vegetation restoration in Potomac River, Chesapeake Bay: Sediment classification. Final Report to the US Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi under BA-08-4281. pp. 82.

King, R.S., A.H. Hines, F.D. Craige and S. Grap. 2005. Regional, watershed and local correlates of blue crab and bivalve abundances in subestuaries of Chesapeake Bay, USA. Journal of Experimental Marine Biology and Ecology 319: 101– 116.

Koch, E. 2001. Beyonod light: Physical, geological, and geochemical parameters as possible submersed aquatic vegetation habitat requirements. Estuaries 24: 1-17.

Koop-Jakobsen K, Giblin AE. 2010. The effect of increased nitrate loading on nitrate reduction via denitrification and DNRA in salt marsh sediments. Limnology and Oceanography 55: 789802.

Langland, Michael and Thomas Cronin. 2003. A summary report of sediment processes in Chesapeake Bay and watershed. US DOI and USGS. Water-Resources Investigations Report 034123. New Cumberland, Pennsylvania.

Leatherman, S.P., R. Chalfont, E.C. Pendletong, T.L. McCandless, and S. Funderburk. 1995. Vanishing lands: Sea level, society and Chesapeake Bay. University of Maryland, Laboratory for Coastal Research, and the US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD.

Leonard, L. and A. Croft. 2006. The effect of standing biomass on flow velocity and turbulence in *Spartina alterniflora* canopies. Estuarine, Coastal and Shelf Science 69:325-336.

Leonard, L.A. 1997. Controls of sediment transport and deposition in an incised mainland marsh basin, southeastern North Carolina. Wetlands 17: 263-274.

Lerberg, S.B., A.F. Holland, and D.M. Sanger. 2000. Responses of tidal creek macrobenthic communities to the effects of watershed development. Estuaries 23: 838–853.

Long, C.W., J.N. Grow, J.E. Majoris, and A.H. Hines. 2011. Effects of anthropogenic shoreline hardening and invasion by *Phragmites australis* on habitat quality for juvenile blue crabs (*Callinectes sapidus*). J. Exp. Mar. Biol. Ecol. 215-222.

Loomis, M.J. and C.B. Craft. 2010. Carbon sequestration and nutrient (nitrogen, phosphorus) accumulation in river-dominated tidal marshes, Georgia, USA. Soil Sci. Soc. Am. J. 74:10281036.

Malone, T.C., W.C. Boicourt, J.C. Cornwell, L.W. Harding, Jr., and J.C Stevenson. 2003. The Choptank River: A Mid-Chesapeake Bay index site for evaluating ecosystem responses to nutrient management. Horn Point Environmental Laboratory, University of Maryland Center for Environmental Science. Cambridge, MD.

Maryland Department of the Environment (MDE). 2008. Shore erosion control guidelines for waterfront property owners, 2nd edition. MDE Water Management Division.

MDE. 2011. Accounting for stormwter wasteload allocations and impervious acres treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits. MDE. Baltimore, MD. Draft.

Merrill, J.Z. and J.C. Cornwell. 2002. The role of oligohaline marshes in estuarine nutrient cycling. Concepts and Controversies in Tidal Marsh Ecology. pp. 425-441.

Merrill, J.Z. 1999. Tidal freshwater marshes as nutrient sinks: Particulate nutrient burial and dentrification. PhD. University of Maryland, College Park. College Park, MD.

Morgan P.A., D.M. Burdick, F.T. Short. 2009. The functions and values of fringing salt marshes in northern New England, USA. Estuaries and Coasts 32: 483–49.

Mudd, S.M. 2013. The life and death of salt marshes in response to anthropogenic disturbance of sediment supply. Geology 39: 511-512.

Neubauer S.C., Anderson,I.C. and Neikirk B.B. 2005. Nitrogen cycling and ecosystem exchanges in a Virginia Tidal Freshwater Marsh. Estuaries 28(6): 909-922.

Neubauer, S., I.C. Anderson, J.A. Constantine, and S.A. Kuehl. 2002. Sediment deposition and accretion in a mid-Atlantic (U.S.A.) tidal freshwater marsh. Estuarine, Coastal and Shelf Science 54: 713-727.

Nixon, S.W. 1980. Between coastal marshes and coastal waters -- a review of twenty years of speculation in the role of salt marshes in estuarine productivity and water chemistry. Estuarine and Wetland Processes. New York, Plenum Press: 437-525.

Nyman, J.A., V.D. Tobias, R.D. DeLaune, and J.D. Foret. 2009. Developing a tool to map coastal wetlands affected and unaffected by freshwater introductions, LUMON Project No. 674139, Interagency Agreement No. CREST07-10. Baton Rouge, LA.

Nyman, J.A., R.J. Walters, R.D. Delaune, and W.H. Patrick, Jr. 2006. Marsh vertical accretion via vegetative growth. Est. Coastal and Shelf Science 69: 370-380.

Otto, S., P. Groffman, S.E.G. Findlay, and A.E. Arreola. 1999. Invasive plant species and microbial processes in a tidal freshwater marsh. J. Environ. Qual. 28:1252–1257.

Palinkas, C.M., Katharina A.M. Engelhardt, and Dan Cadol. 2013. Estuarine. Evaluating physical and biological influences on sedimentation in a tidal freshwater marsh with ^{7}Be. Coastal and Shelf Science 129: 152-161.

Palinkas C.M. and J. Cornwell. 2012. A preliminary sediment budget for the Corsica River (MD): improved estimates of nitrogen burial implications for restoration. Estuaries and Coasts 35: 546-558.

Palinkas, C.M. and E.W. Koch. 2012. Sediment accumulation rates and submersed aquatic vegetation (SAV) distributions in the mesohaline Chesapeake Bay, USA. Estuaries and Coasts 35: 1416-1431.

Patrick, CJ, DE Weller, X Li, M Ryder. *In press*. Effects of shoreline alteration and other stressors on submerged aquatic vegetation in subestuaries of Chesapeake Bay and the midAtlantic Coastal Bays. Estuaries and Coasts.

Peterson, M.S., B.H. Comyns, J.R. Hendon, P.J. Bond, and G.A. Duff. 2000. Habitat use by early life-history stages of fishes and crustaceans along a changing estuarine landscape:differences between natural and altered shoreline sites. Wetlands Ecol. Manage. 8: 209–219.

Pilkey, Orrin H., Rob Young, Norma Longo, and Andy Coburn. 2012. Rethinking living shorelines. Nicholas School of the Environment, Duke University. Durham, NC. Available online at: http://www.wcu.edu/WebFiles/PDFs/PSDS_Living_Shorelines_White_Paper.pdf

Pister, B., 2009. Urban marine ecology in southern California: the ability of riprap structures to serve as rocky intertidal habitat. Mar. Biol. 156: 861–873.

Proctor, Daniel. 2012. PR Farm – Shoreline nutrient credit case study: Initial credit estimate summary. Memorandum to Craig Suro (PR Farm, LLC). Williamsburg Environmental Group. Williamsburg, VA.

Pyke, C. R., R. G. Najjar, M. B. Adams, D. Breitburg, M. Kemp, C. Hershner, R. Howarth, M. Mulholland, M. Paolisso, D. Secor, K. Sellner, D. Wardrop, and R. Wood. 2008. Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations. A Report from the Chesapeake Bay Program Science and Technical Advisory Committee (STAC), Annapolis, MD.

Rosencranz, J.A. 2012. Accretion, sediment deposition and suspended sediment dynamics in Mugu Lagoon, a Southern California coastal estuary. UCLA Thesis.

Ruiz, G.M., A.H. Hines, and M.H. Posey. 1993. Shallow-water refuge habitat for fish and crustaceans in non-vegetated estuaries: an example from Chesapeake Bay. Mar. Ecol. Progr. Ser. 99:1-16.

Schubauer, J.P. and C.S. Hopkinson. 1984. Above-and belowground emergent macrophyte production and turnover in a coastal marsh ecosystem, Georgia. Limnological Oceanography 29 (5): 1052-1065.

Scyphers S.B., S.P. Powers, K.L.Heck Jr, D. Byron. 2011. Oyster Reefs as Natural Breakwaters Mitigate Shoreline Loss and Facilitate Fisheries. PLoS ONE 6(8): e22396. doi:10.1371/journal.pone.0022396.
Virginia Institute of Marine Science (VIMS). 2013. Accessed 7/26/13. http://ccrm.vims.edu/livingshorelines/policy_legislation/index.html

Seitz, R.D., R.N. Lipcius, N.H. Olmstead, M.S. Seebo, and D.M.Lambert. 2006. Influence of shallowwater habitats and shoreline development upon abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay. Marine Ecology Progress Series 326: 11–27.

Seitzinger, S.P. 1988. Denitrification in freshwater and coastal marine ecosystems: Ecological and geochemical significance. Limnology and Oceanography 33: 702-724.

Smith, C.G., L.E. Osterman, and R.Z. Poore. 2013. An examination of historical inorganic sedimentation and organic matter accumulation in several marsh types within the Mobile Bay and Mobile-Tensaw River Delta region. J. Coastal Res. 63:63-83.

Stedman, Susan-Marie and Thomas E. Dahl. 2008. Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998 to 2004. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Department of the Interior, Fish and Wildlife Service.

Stevenson, J.C., M.S. Kearney, and E.C. Pendleton. 1985. Sedimentation and erosion In a Chesapeake Bay brackish marsh system. Marine Geology 67: 213-235.

Strange, Elizabeth M. 2008. The Atlantic side of the Virginia eastern shore. Section 3.9 in: Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1, J.G. Titus and E.M. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC.

Stream Restoration Expert Panel. 2013. Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects: Final Draft (April 2013).

Swann, L. 2008. The use of living shorelines to mitigate the effects of storm events on Dauphin Island, Alabama, USA. American Fisheries Society Symposium. 64:1-11.

Tiner . Ralph W. and John T Finn. 1986. Status and recent trends of wetlands in five MidAtlantic states: Delaware, Maryland, Pennsylvania, Virginia, and West Virginia. National Wetlands Inventory. US Fish and Wildlife Service. Newton Corner, MA.

Titus, J.G., D.E. Hudgens, C.Hershner, J.M. Kassakian, P.R. Penumalli, M. Berman, and W.H. Nuckols. 2010. “Virginia”. In James G.Titus and Daniel Hudgens (editors). The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 1: Mid-Atlantic. Report to the U.S. Environmental Protection Agency. Washington, D.C.

Tobias, C. and S.C. Neubauer. 2009. Salt marsh biogeochemistry – an overview. In: Coastal Wetlands: An Integrated Ecosystem Approach., G.M.E. Perillo, E. Wolanski, E.R. Cahoon, and M.M. Brinson, editors, pp. 445-492.

Tobias, Craig R., Iris C. Anderson, Elizabeth A. Canuel, and Stephen A. Macko. 2001. Nitrogen cycling through a fringing marsh-aquifer ecotone. Marine Ecology Progress Series 210: 25-39.

Valiela, I., M. Cole, J. McClelland, J. Hauxwell, J. Cebrian, and S. Joye. 2000. Role of salt marshes as part of coastal landscapes. P. 23-38. In. M. Weinstein and D. Kreeger (eds). Concepts and Controversies in Tidal Marsh Ecology. Kluwer, Boaston, MA., USA.

Virginia Institute of Marine Science (VIMS). 2013. Tidal wetlands management technical support. Center for Coastal Resource Management. Grant #NA12NOS4190168, Task #7.

Vogel, R.L. 1996. Inorganic sediment budgert for the North Inlet salt marsh, South Carolina, U.S.A. Mangroves an Salt Marshes 1:23-35

WQGIT. 2012. Applying the decision framework to attaining water quality standards in the Chesapeake Bay and its tidal tributaries. Chesapeake Bay Program Office. Annapolis, MD. Available online at: http://www.chesapeakebay.net/publications/keywords/WQGIT

Water Quality Goal Implementation Team (WQGIT). 2010. Protocol for the development, review, and approval of loading and effectiveness estimates for nutrient and sediment controls in the Chesapeake Bay Watershed Model. Chesapeake Bay Program Office. Annapolis, MD. Available online at: http://www.chesapeakebay.net/publications/title/bmp_review_protocol

Weis, J.S., Weis, P., Proctor, T., 1998. The extent of benthic impacts of CCA-treated wood structures in Atlantic coast estuaries. Arch. Environ. Contam. Toxicol. 34: 313–322.

White, D.S. and B.L. Howes. 1994. Long-term ^{15}N-nitrogen retention in the vegetated sediments of a New England salt marsh. Limnology and Oceanography 39: 1878-1892.

Windham, L. and L.A. Meyerson. 2003. Effects of common reed (*Phragmites australis*) expansions on nitrogen dynamics of tidal marshes of northeastern US. Estuaries 26:452–464.
Zervas, C. 2001. Sea level variations of the United States, 1854–1999, NOAA Technical Report NOS CO-OPS 36.

Zelenke, J.L. and J.C. Cornwell. 1996. Sediment accretion and composition in four marshes of the Chesapeake Bay. Final Report. Horn Point Environmental Laboratory, University of Maryland Center for Environmental and Estuarine Studies. Cambridge, Maryland.

Zervas, C. 2001. Sea Level Variations of the United States 1854–1999. National Oceanic and Atmospheric Administration Technical Report NOS CO-OPS 36.

Appendix B. Panel's Conformity with the BMP Review Protocol Requirements

The BMP review protocol established by the Water Quality Goal Implementation Team (WQGIT, 2010) outlines the expectations for the content of expert panel reports. This appendix references the specific sections within the report where panel addressed the requested protocol criteria.

1. **Identity and expertise of panel members***: Table 2 in Section 1.1 Panel M embers*

2. **Practice name or title:** *Shoreline Management*

3. **Detailed definition of the practice***: Section 2 Definitions and Geographic Scope – 2.1.3 Expert Panel Definition*

4. **Recommended N, P and TSS loading or effectiveness estimates:** *Section 5 Rationale, Methods, and Examples for New Shoreline Management Protocols*

5. **Justification of selected effectiveness estimates***: Section 3 Shore Erosion and Management in the Chesapeake Bay and Section 5 Rationale, Methods, and Examples for Shoreline Management Protocols*

6. **List of references used***: References, Appendix C Technical Requirements for Entering Shoreline Management Practices into Scenario Builder, Appendix J Marsh Redfield Ratio Data (Table 24), and Appendix L Dissenting View Document*

7. **Detailed discussion on how each reference was considered***: Section 5 Rationale, Methods, and Examples for New Shoreline Management Protocols*

8. **Land uses to which BMP is applied:** *All land uses that meet qualifying conditions*

9. **Load sources that the BMP will address and potential interactions with other practices:** *Shoreline management practices will prevent tidal shore erosion. The BMP may compliment and/or overlap with wetland and/or coastal wetland practices.*

10. **Description of pre-BMP and post-BMP circumstances and individual practice baseline:** *See Protocols 1, 2, 3, and 4 in Section 5 Rationale, Methods, and Examples for New Shoreline Management Protocols*

11. **Conditions under which the BMP works/not works**: *See the Section 4 Basic Qualifying*

Conditions for Individual Projects and Section 6 Accountability and Unintended Consequences

12. **Temporal performance of BMP including lag times between establishment and full functioning.** *NA*

13. **Unit of measure:** *Mass of TN, TP, or TSS reduced, which depends on project design factors and the applicable protocol(s)*

14. **Locations in CB watershed where the practice applies:** *Anywhere a project meets the qualifying conditions. See Section 2.2 Geographic Boundary and Section 4.2 Basic Qualifying Conditions for Individual Practices.*

15. **Useful life of the BMP:** *5 years, but renewable based on visual inspection. See Section 6.1.4.2 Duration of Shoreline Management Credit.*

16. **Cumulative or annual practice:** *Cumulative pollutant load reductions for Protocols 1, 2, 3 and 4. See Section 5 Rationale, Methods, and Examples for New Shoreline Management Protocols.*

17. **Description of how BMP will be tracked and reported:** *See Section 6.1 Reporting, Tracking, and Verification*

18. **Ancillary benefits, unintended consequences, double counting***: See Section 3.3 Shoreline Management and Habitat Impacts, Section 4.1.3 SAV Habitat, Section 4 Basic Qualifying Conditions for Individual Projects, and Section 7.1 Panel's Confidence in Recommendations.*

19. **Timeline for a re-evaluation of the panel recommendations** *In two years and every two years after that time. See Section 7.1.1 Proposed Timeframe for Panel Recommendations Review and Update.*

20. **Outstanding Issues**: *Model pollutant load and the respective protocols that receive the pollutant load reductions will be finalized by the appropriate CBPO Workgroup(s)*

21. **Pollutant relocation:** *None*

Appendix C. Technical Requirements for Entering the Shoreline Management Practice into Scenario Builder and the Watershed Model

Revisions to Table 1 approved by WTWG: June, 2017

Background: In June, 2013 the Water Quality Goal Implementation Team (WQGIT) agreed that each BMP expert panel would work with CBPO staff and the Watershed Technical Workgroup (WTWG) to develop a technical appendix for each expert panel report. The purpose of this technical appendix is to describe how the Shoreline Management Expert Panel's recommendations will be integrated into the modeling tools including NEIEN, Scenario Builder and the Watershed Model.

Q1. What are the reductions a jurisdiction can claim for Shoreline Management practices implemented after the calibration period (post-2005) in the Phase 5.3.2 Watershed Model?

A1. The panel recommended that all new shoreline management projects could receive credit for reducing nutrients and sediment through four distinct protocols which target different aspects of typical shoreline management designs. The table below lists each protocol's default nutrient and sediment reductions.

Table 1. Pollutant Reductions Available from Each Protocol

Protocol	Submitted Unit	Total Nitrogen (lbs per unit)	Total Phosphorus (lbs per unit)	Total Suspended Sediment (lbs per unit)
Protocol 1 - Prevented Sediment	Linear Feet	Project-Specific*	Project-Specific*	Project-Specific
Protocol 2 – Denitrification	Acres of re-vegetation	85	NA	NA
Protocol 3 - Sedimentation	Acres of re-vegetation	NA	5.289	6,959
Protocol 4 – Marsh Redfield Ratio	Acres of re-vegetation	6.83	0.3	NA
Non-conforming/Existing Practices *	Linear Feet	MD = 0.04756 VA = 0.01218	MD = 0.03362 VA = 0.00861	MD = 164 VA = 42

*The WTWG initially recommended no reductions for TN and TP until the Modeling Workgroup had an opportunity to evaluate the availability of TN and TP in shoreline sediments in 2017. The WTWG approved the reductions following this analysis which analysis estimated an average of 0.00029 lbs TN/ lb of TSS and 0.000205 lbs TP/ lb of TSS in eroded tidal shoreline sediment. These values can be used directly by jurisdictions for their calculations in Protocol 1, and were adapted for non-conforming/existing practices by multiplying by the default TSS reduction for non-conforming projects by the average nutrient concentrations in sediment. Note: the MD numbers also apply to , DE and DC. The default rate for sediment is based on fine sediment erosion estimates from Table 3 and a 50% reduction factor applied. The first number applies to MD, DE and DC and the second number applies to VA.

Q2. Is there a default credit available for jurisdictions for planning purposes and practices that do not have detailed reporting?

A2. Yes. A jurisdiction may claim the existing default pound reductions listed in Table 1 above for planning purposes or for non-conforming or existing practices.

Q3. What types of projects are eligible to receive credit in the Phase 5.3.2 Watershed Model?

A3. The panel defined Shoreline Management as "any tidal shoreline practice that prevents and/or reduces tidal sediments to the Bay." (p. 9) Shoreline Management practices can include living shorelines, revetments and/or breakwater systems and bulkheads and seawalls. Additionally, only practices with vegetative surface areas can receive credit for Protocol 2, Protocol 3 and Protocol 4. Regardless of the design, all practices must meet the qualifying conditions described in the Table 2 below (p.26).

Table 2. Shoreline Management Criteria to Receive Pollutant Load Reductions

Shoreline Management Practice	The Practice Must Meet these Criteria for TMDL Pollutant Load Reduction[1]
Living Shoreline – a) nonstructural; b) hybrid system including a sill; and c) hybrid system including a breakwater	1. The site is currently experiencing shoreline erosion or is replacing existing armor. The site was graded, vegetated, and excess sediment was removed or used.[2] AND 2. When a marsh fringe habitat (a or b) or beach/dune habitat (c) is created, enhanced, or maintained.
Revetment AND/OR Breakwater system without a living shoreline	1. The site is currently experiencing shoreline erosion. The site was graded, vegetated, and excess sediment was removed or used.[2] AND 2. A living shoreline is not technically feasible or practicable as determined by substrate, depth, or other site constraints. AND 3. When the breakwater footprint would not cover SAV, shellfish beds, and/or wetlands.
Bulkhead/Seawalls	1. The site is currently experiencing shoreline erosion. AND 2. The site consists of port facilities, marine industrial facilities, or other marine commercial areas where immediate offshore depth (e.g., depths deeper than 10 feet 35 feet from shore) precludes living shoreline stabilization or the use of a breakwater or revetment.
[1]Projects that impact the Chesapeake Bay Preservation Act protected vegetation without mitigation receive no Chesapeake Bay TMDL pollutant load reduction. [2]Bank analysis that demonstrates the site has bank stability and does not have erosion can serve to meet this qualifying condition. This should be coordinated with the local reporting authority to	

Shoreline Management Practice	The Practice Must Meet these Criteria for TMDL Pollutant Load Reduction[1]
ensure proper methods, reporting, and requirements are done and are accepted by that authority so that the project meets this basic qualifying condition.	

Q4. Can a shoreline management project qualify for multiple protocols?

A4. Yes. Practices that have BOTH vegetated areas and are designed to prevent sediment erosion may qualify for reductions from all four protocols. These reductions will be added together in Scenario Builder. Practices that do not have vegetated areas may only qualify for Protocol 1 – Prevented Sediment.

Q5. What do jurisdictions need to submit to NEIEN in order to qualify for reductions under the protocols listed in Table 1?

A5. Below is a complete list of the parameters that should be submitted to NEIEN for each project.

- BMP Name: Urban Shoreline Management; Urban Shoreline Non-Vegetated; Urban Shoreline Vegetated; Ag Shoreline Management; Ag Shoreline Non-Vegetated; Ag Shoreline Vegetated
- Measurement Name and associated unit amount: Length Restored; Acres Planted; Protocol 1 N; Protocol 1 P; Protocol 1 TSS
- Land Use: N/A; this BMP will be simulated adjacent to or within tidal waters.
- Location: Approved NEIEN geographies: Latitude/Longitude (preferred);County; County (CBWS Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4), State (CBWS Only)
- Date of Implementation: year the project was completed

Q6. How should a jurisdiction report a practice with no vegetation?

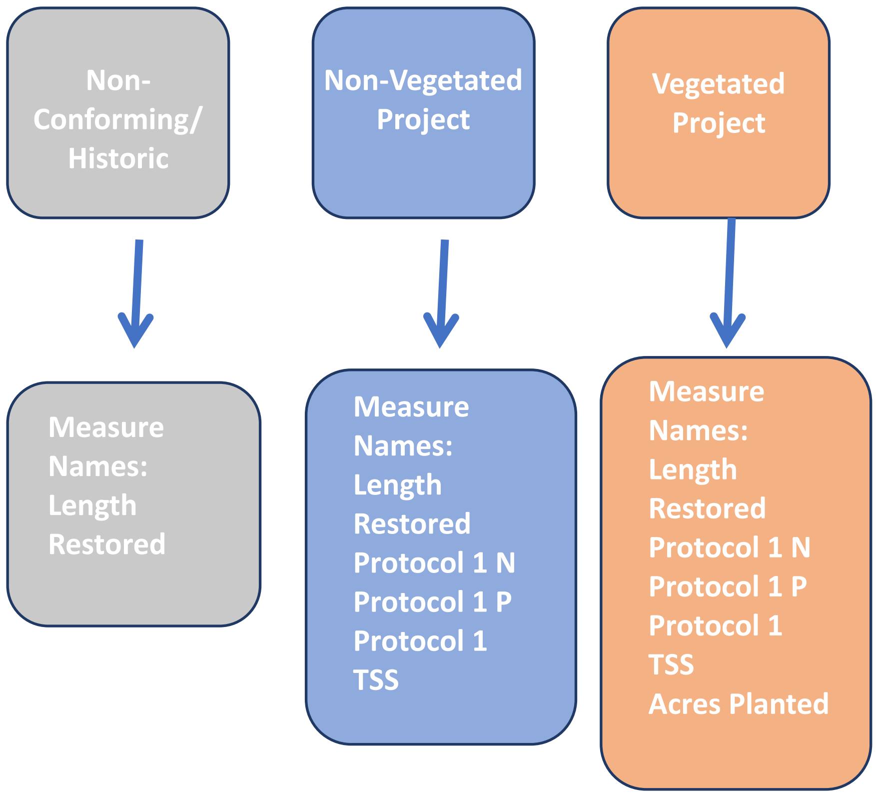
A6. If jurisdictions wish to receive credit for non-vegetative shoreline management practices beyond the default, non-conforming rates, they should report the Length Restored AND Protocol 1 N, Protocol 1 P and Protocol 1 TSS measurement names to NEIEN. The values for each of these measurement names can be found using the equations presented in Section 5.2.1 of the expert panel report (p. 32-35). See the flowchart below question 7 for a detailed description of NEIEN submission needs.

Q7. How should a jurisdiction report a practice with vegetation?

A7. If a jurisdiction wishes to claim credit beyond the default, non-conforming rates for vegetative shoreline management practices, they should report Length Restored, Acres Planted AND Protocol 1 N, Protocol 1 P, and Protocol 1 TSS measurement names to NEIEN. The values for each of the Protocol 1 measurement names can be found using the equations presented in

Section 5.2.1 of the expert panel report. See the flowchart below question 7 for a detailed description of NEIEN submission needs.

Flowchart of NEIEN Reporting Requirements



Q8: How will the modeling tools simulate reductions from shoreline management practices?

A8: Tidal shoreline erosion occurs at the interface between the watershed and the Chesapeake Bay's tidal waters. The Watershed Model domain ends at the tidal shoreline, and shoreline erosion loads are actually simulated by the estuarine Water Quality Sediment Transport Model (WQSTM). The load reductions, therefore, will be simulated as reductions in the WQSTM.

During the 2017 mid-point assessment, the WQSTM was modified to explicitly simulate nutrient loads from the shoreline, so the Phase 6 Watershed Model is no longer needed for reporting of shoreline load reduction..

Q9. Is this BMP an annual or cumulative practice?

A9. The BMP is a cumulative practice. Jurisdictions should report all measurement names only at the time of installation. The practice will continue to receive credit in the model in future years.

Q10. How will the existing Shoreline Erosion Control practices be simulated in the modeling tools?

A10. To date, no jurisdiction has submitted Shoreline Erosion Control in a progress or planning scenario. This BMP will be removed. All new shoreline management projects should be reported under the new BMP name.

Q11: Is there a cap on the potential reductions from shoreline management practices?

A11: No. Due to the changes in how shoreline is now simulated in the WQSTM, there is no cap on potential shoreline load reductions (when the individual protocols are properly applied)..

Q12. Where do projects need to be located to receive credit for this BMP as opposed to for the Stream Restoration BMP?

A12. Jurisdictions should only submit projects that are adjacent to tidal waters. All restoration activities which limit sediment erosion on non-tidal waters should be submitted as Stream Restoration following the guidelines described by Stream Restoration Panel. The panel included a map of the modeling segments adjacent to tidal water on p. 11 of the report.

Q13. Can jurisdictions submit historic shoreline management practices for credit?

A13. Yes. Jurisdictions can submit any practices that were implemented post-2008 for credit in the modeling tools. The WQSTM already accounts for shoreline practices in place as of 2008. Jurisdictions may also submit any shoreline management practices implemented prior to 2008 as part of the historic BMP cleanup effort.

Appendix D. Shoreline Management in Chesapeake Bay: A Comprehensive Approach

According to Hardaway and Byrne (1999), before any shoreline strategy is planned, the site should be evaluated in the context of the "reach." A "reach" is defined as a segment of shoreline where the erosion processes and responses mutually interact. For example little sand is transported by wave action beyond a major headland creek mouth, tidal inlet or major change in shoreline orientation. One to several properties may be contained along a reach. In highly developed areas there will be several properties in a reach.

It may not be possible for all property owners to have a site assessed, but knowing the basic elements that go into an evaluation should be helpful. Reach assessments involve the following six principal points:

1. Determine the reach limits in which the project site is located.
2. Determine the historical rates and patterns of erosion and accretion for the reach. Identify shore types (upland banks, marsh, etc.) and impacts to shoreline erosion processes and evolution.
3. Determine within the reach which areas supply sand and the volume of that supply for incremental erosion distances. Often, there can be subreaches that interact with each other. These subreaches supply sediment to the other subreaches (erosion), transport sediment from one subreach to the next, or are subreaches where sediment accumulates (accretion). A reach may feature all three types of subreaches.
4. Determine the wave climate and the net direction of littoral sand drift.
5. Identify the factors causing or influencing erosion (other than waves). These may include groundwater seepage, freeze thaw, surface runoff, or other processes.
6. Estimate potential and active sources of nutrient loading (i.e., farmland, commercial, or residential land) and the means by which this occurs, such as surface runoff, eroding sediments, and/or groundwater discharge. Nutrients, particularly nitrogen and phosphorous, do not impact erosion, but they do impact water quality. Installing breakwaters, revetments or other shoreline erosion treatments, inevitably change water discharge and shore change patterns and thus overall water quality. In order to minimize water quality problems, shoreline erosion strategies can and should be designed so that nutrients don't adversely impact water quality or are actually treated by the strategy.

Understanding the size of the reach and those factors which influence the reach provides property owners a sense of the spatial parameters to address shoreline erosion, help frame the problem, and put the problem (e.g., erosion) and solution (e.g., shoreline management practice) into context. These considerations can support sustainable shoreline management.

Appendix E. Policy and Permits

Maryland and Virginia's preferred shoreline management approach is to use living shorelines where appropriate to prevent shoreline erosion and to protect the associated habitat. Maryland is a "high water state" meaning the jurisdictional line is at MHW (mean high water) and Virginia is a "low water state" meaning the jurisdictional line is at the MLW (mean low water). The policy and permit structure differs in the states, but the goals to protect property, prevent erosion, promote nearshore water habitat, and prevent unintended consequences are similar for the states.

Maryland

In Maryland, the Living Shoreline Protection Act of 2008 provides this regulatory authority. The regulations were final in February 2013 and include the following guidance:

- *HB973 – Living Shoreline Protection Act of 2008* "Improvements to protect a person's property against erosion shall consist of non-structural shoreline stabilization measures (i.e., living shorelines) that preserve the natural environment, such as marsh creation" (MDE).
- The regulatory definition of Nonstructural Shoreline Stabilization Measures or "living shoreline" is a suite of stabilization and erosion control measures that preserve the natural shoreline and are designed to minimize shoreline erosion, maintain coastal processes, and provide aquatic habitat.
- Property owners that demonstrate nonstructural practices are not feasible can obtain a waiver.

Guidance documents, checklists, and sample plans are underway for Maryland projects. Permits and application forms in Maryland are obtained through the MDE and require the following (from MDE's website at http://www.mde.state.md.us/programs/Water/WetlandsandWaterways/Pages/TidalRegsLivingShoreline.aspx):

- Joint federal/state application for the alteration of any tidal wetland
- Proposed critical area buffer management plan
- Signed critical area buffer notification form
- If applicable, a living shoreline waiver request form

Virginia

In Virginia, Senate Bill 964 established living shorelines as the preferred approach to shoreline erosion protection in 2011. The legislation mandates the development of a living shorelines general permit and the development of integrated guidance to direct shoreline management. Senate Bill 964 calls for the following:

- Living shorelines definition;
- Requires VMRC to develop a general permit;
- Encourages the use of living shorelines as the preferred practice to stabilize tidal shorelines;
- Requires VMRC to develop guidance for tidal shoreline management;
- Requires Tidewater localities to incorporate the VIMS guidance in their comprehensive plans starting with scheduled reviews in 2013; and
- Requires VIMS to develop comprehensive coastal resource management guidance by 12/30/12. This guidance is locality specific GIS analysis for shoreline management BMPs. The guidance is delivered via map-viewer along with documentation in report form. VIMS creates the shoreline model map viewers over time. Rationale and general information is online at http://ccrm.vims.edu/ccrmp/Guidance_General.pdf

Virginia's shoreline management policy guidance is ongoing. In Maryland and Virginia, living shorelines are the preferred management strategy.

In Virginia, the joint permit is submitted to VMRC who then submits to the appropriate local wetland board, DEQ, and the US Army Corps of Engineers. The applicant usually has to have a permit or waiver from each agency before beginning construction. See Figure 12 for the permit process in Virginia.

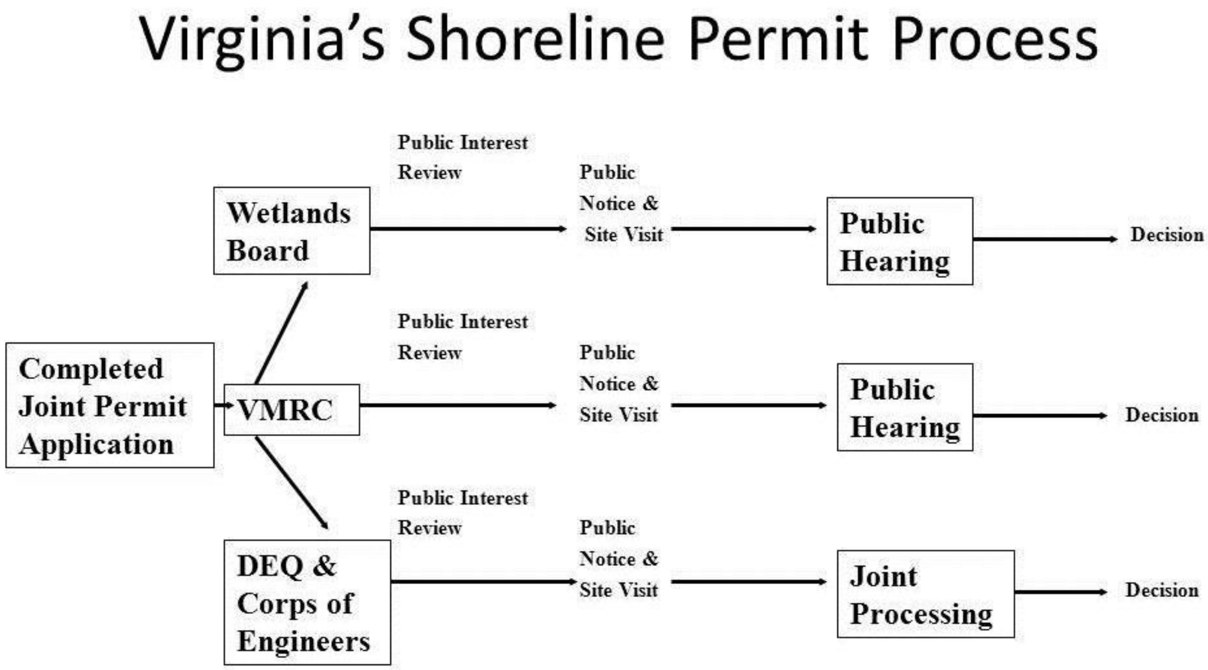


Figure 12. Virginia's shoreline permit process. This figure is courtesy of Tony Watkinson (VMRC) presentation to the panel on 2/25/13.

Delaware

The western part of Delaware is located within the Chesapeake Bay watershed, which includes the coastal plain and the Nanticoke River drainage. The findings in this report can be translated to the coastal shorelines in Delaware.

In Delaware, the 7504 Regulations Governing the Use of Subaqueous Lands, 4.10 Installation and Use of Shoreline Erosion Control Measures outlines the use of nonstructural shoreline practices as the first, preferred shoreline management strategy. The policy states,

"Efforts shall be made to utilize shoreline erosion control methods that best provide for the conservation of aquatic nearshore habitat, maintain water quality, and avoid other adverse environmental effects. These include, but are not limited to, vegetation, revetments, and gabions. Structural erosion control measures may be allowed where it can be shown, through a review of site conditions and generally accepted engineering standards, that nonstructural measures would be ineffective in controlling erosion." The state jurisdictional line is the mean low water. This policy is online at: http://regulations.delaware.gov/AdminCode/title7/7000/7500/7504.shtml#TopOfPage

A USACOE Nationwide 13 permit is needed for bank stabilization projects. These hard structures are the most prevalent practices for shoreline stabilization in the state. The state has a living shoreline Statewide Activity Application (SAA) that includes statewide activity approval for disturbances less than 500 ft^2. The SAA project must have a vegetative component. SAA benefits include no public notice and a cost-share program for vegetated or hybrid shoreline management practices.

District of Columbia

The District of Columbia is a heavily developed, urban community. The US Army Corps of Engineers - Baltimore District issues all District of Columbia permits for work in waters of the United States including jurisdictional wetlands and shoreline management projects. These permits have to be certified by District Department of the Environment (DDOE) Water Quality Division under Section 401 of the Clean Water Act.

The District of Columbia permitting details are available online at: http://www.nab.usace.army.mil/Missions/Regulatory/PermitTypesandProcess.aspx

Appendix F. Sea Level Rise Considerations for Shoreline Management Practices

The Shoreline management expert panel realizes that future sea level rise (SLR) considerations for shoreline management practices are needed. The design, maintenance, and ultimate effectiveness can be impacted by rising waters and/or more intense storm events. Based on the available information there is a need to consider the future impacts to the shoreline management options provided in this panel report.

The CBPO asked the Science and Technical Advisory Commission (STAC) to review the effects of climate change on the Chesapeake Bay. The STAC produced a report that summarized the available science and recommended the Bay Program and its partners assess the vulnerability of living resource restoration efforts to climate change and require that projects take specific steps to increase the likelihood of success under changing conditions (Pyke et al., 2008). Shoreline erosion control practices can provide pollution reduction benefits and their long term stability and function should be considered in the context of climate change and specifically SLR impacts.

There are several Chesapeake Bay coastal climate change impacts that include storm intensity, precipitation level, wave action, and habitat impact such as SAV, fish, oysters, etc. (Pyke et al., 2008; CBPO, 2005). Sea level rise during the second half of the 20th century was monitored at six sites in the Bay and reported to range from 2.7 to 4.5 mm yr^{-1} with an average of 3.5 mm yr^{-1} (Zervas, 2001). Maryland's "A Sea Level Rise Response Strategy for the State of Maryland" (Johnson, 2000) states, "The average rate of SLR along Maryland's coastline has been 3 to 4 mm/yr, or approximately one foot per century. Such rates are nearly twice those of the global average (1.8 mm yr^{-1}), a result probably due to substantial land subsidence. Furthermore, research has demonstrated that SLR rates will accelerate in response to global warming, resulting in a rise of 2 to 3 feet by the year 2100 (Leatherman et al., 1995). A rise in sea level of this magnitude will undoubtedly have a dramatic impact on Maryland's coastal environment. Norfolk, VA has an estimated 2 feet (± 0.7) feet sea level relative to the land above the mean sea level by 2050. The linear rise rate in Norfolk was 5 mm y^{-1} and is consistent with a high linear subsidence rate in Norfolk (Boon, 2012). Virginia's southern coast will be impacted more from subsidence coupled with SLR (Titus et al., 2010). Current research suggests that wetlands in VA will not accrete fast enough to compensate for increases in water depth due to SLR (Titus et al., 2010). Therefore, SLR is an important to consider in the VA and MD tidal areas.

The latest Status and Trends of Wetlands in The US 2004-2009 (Dahl, 2011) reported the loss of approximately 111,000 acres of emergent estuarine wetlands; this is 2.4% of the total. This report stated the following:

- In salt water systems, the trend is towards an increase in non-vegetated tidal wetlands as vegetated salt marshes decline.
- The increase in tidal non-vegetated area came primarily from former vegetated salt marsh.
- Ninety nine percent of losses of estuarine emergent wetlands were attributed to the effects of coastal storms, land subsidence, sea level rise, or other ocean processes.
- Eighty three percent of the estuarine emergent losses were attributed to saltwater intrusion or other forms of inundation.
- Rising sea levels are expected to continue to inundate or fragment low-lying coastal habitats.
- Coastal habitats will likely be increasingly stressed by climate change impacts that have resulted from sea level rise and coastal storms of increasing frequency and intensity

The ability for coastal marshes and wetlands to migrate landward is essential for land protection and to prevent wetlands from "drowning in place." This is especially true where policy research suggests, that developed coastal areas will move to and be allowed to harden shorelines in response to SLR. Marshes and/or wetlands creation channelward of hardened shorelines will not be able to migrate landward in response to SLR in urban areas (Glick et al., 2008). Also, steep slopes, wetland mowing, and other "management" activities prevent existing, created, restored, or enhanced coastal marshes and wetlands from providing their initial and intended pollution reduction. As a result, tracking and verification timeframes should assess the loss of acreage and function of wetlands over time. In addition, structure-induced toe scour may also affect the function and value, therefore the verification inspections should be conducted annually.

For living shoreline management projects, active marsh and/or wetland intervention may be needed to combat the effects of SLR over time. Intervention may be needed most on the developed coastlines where urban development prevents landward migration in response to SLR. This intervention can take many forms that include, but are not limited to the following:

- Raising sill heights and active filling of existing wetland grades to meet zonation elevation requirements for both vegetated and nonvegetated wetlands. ○ One limitation is that the US Army Corps of Engineers and state agencies must comply with a no net loss of wetlands.

- o Therefore living shoreline projects, especially those that are designed to account for SLR may involve permitting issues related to the no net loss of wetland and the conversion of one aquatic habitat to another.

- Filling nonvegetated subtidal lands and converting them to intertidal vegetated and nonvegetated wetlands.

Several policy, research, and implementation options are available to manage in the context of future SLR. Federal, state, and local policies, guidelines, and regulations affirm the ecological values and services that tidal marshes and wetlands provide. However, in order to recognize and sustain the tidal marsh and wetland vital ecosystem services in response to SLR threats, both the existing natural resources and the restoration BMPs need improved inventory strategy and methods. In addition, the shoreline management practice type and placement along the coast should consider the local SLR information. The following coastal restoration and management options were provided by the National Wildlife Federation (Glick et al., 2008):

1. Prioritize project sites based on ecological importance as well as vulnerability to SLR
2. Expand restoration areas and coastal protection strategies to accommodate for habitat migration
3. Restore and protect a diverse array of habitat types to better support ecosystem functions and improve the resiliency of fish and wildlife species.
4. Identify areas that may warrant specific adaptation strategies such as natural and/or artificial replenishment of sediments
5. Expand monitoring and adaptive management practices.

In summary, SLR considerations for shoreline management practice design, implementation, maintenance, tracking, and verification should be updated with the best available information. Future CBPO SLR research can further the Shoreline Management expert panel recommendation implementation phase, can be the focus of CBPO workshops/workgroups, and/or can be considered in the Goal Implementation Team initiatives.

Appendix G. Shoreline Management Site Conditions and Benchmarks

Additional benchmarks the panel recommended for basic qualifying conditions included: 1) shoreline sediment type; 2) nearshore bottom type; 3) shoreline morphology and orientation; 4) back shore area type; 5) bank conditions; 6) boat traffic; and 7) policy considerations. See Table 23 for a summary of these benchmarks. These benchmarks are guidance to support the existing state requirements.

Table 23. Shoreline management site conditions and benchmarks.

Site Condition	Benchmarks
Fetch	• High: 5 to 15 miles • Medium: 1 to 5 miles • Low: < 1 miles
Wave Energy	• High: Bay • Medium: River • Low: Creek
Depth Offshore	• At 10 ft offshore • At 25 ft offshore • At 50 ft offshore
Erosion Rate	• Very High: > 10 ft/yr • High: 5 to10 ft/yr • Moderate: 2 to 5 ft/yr • Slight: < 2 ft/yr
Shoreline Sediment (at MHW)	• Sandy • Clayey • Silty • Mucky • Organic
Nearshore Bottom (at 10 feet, 25 feet and 50 feet)	• Sandy • Clayey • Silty • Mucky • Organic
Shoreline Morphology	• Straight • Irregular • Headland • Pocket (cove)
Backshore Area (Area above and beyond MHW)	• Dunal • Marsh • Forest • Bank
Bank Conditions	• Height • Slope

Site Condition	Benchmarks
	• Composition • Vegetated (% cover) • Type of Vegetation • Stable or Eroding • Undercut
Boat Traffic (From May - September)	• High Traffic Area • Moderate Traffic Area • Low Traffic Area
Tidal range and orientation are also important to determine benchmarks at the local level.	

Appendix H. Tidal marsh denitrification rates in or near the Chesapeake Bay.

The following studies conducted in and near the Chesapeake Bay watershed provide support for the tidal marsh system as a nutrient and sediment load reduction BMP.

- In the Patuxent River, the accreting tidal marsh removed 30% of the total nitrogen and 31% of the total phosphorus from the estuarine/marsh system. This highlights the tidal marsh nutrient reduction capability and the importance for accretion to exceed sea level rise in order to provide these ecosystem services (Boynton et al., 2008).
- The Choptank River tidal marshes retained about 33% total nitrogen and about 94% total phosphorus in the marsh sediments (Malone et al., 2003). The authors state, "In tidal Chesapeake estuaries, tidal marshes represent a large, and previously ignored sink for N and P."
- Five fringe salt marshes in Narragansett Bay, Rhode Island, showed denitrification rates up to 420 µmol N_2 m^2 hr^{-1} to intercept and transform land-derived nitrogen loads (Davis et al., 2004). Denitrification is a major pathway to remove inorganic nitrogen from the estuarine system (Seitzinger, 1988).
- The Dyke Marsh is a tidal freshwater marsh on the Potomac River. The mean denitrification rate was 147 µmol N m^{-2} h^{-1}. Using this rate for the Dyke Marsh area, the potential N removal is 14,600 kg yr^{-1} (Hopfensperger et al., 2009).
- In the Rhode River estuary, tidal marshes transformed particulate nutrients to dissolved nutrients. The marshes retained phosphorus by accumulation on the sediment. Based on the phosphorus retention the high marsh and mudflat are estimated to accrete 3 mm per year (Jordan et al., 1983).
- Another study in the Rhode River estuary found that phytoplankton in the upper estuary led to higher phosphorus than nitrogen removal (Jordan et al., 1991).
- Continuous automated sampling of two tidal marshes in both the high and low marsh over two to three years found that the high marsh exported material and the low marsh imported material and had deposition (Jordan et al., 1991).
- Tidal marshes are effective at trapping sediment both as individual grains and as flocculants. Tidal marsh vegetation plays a role by reducing velocity and breaking up turbulent eddies that might result in resuspension of deposited sediment (Christianson et al., 2000).

The literature review found that denitrification was an important nitrogen removal pathway in vegetative systems. The nitrogen removed in tidal marshes and fringing marshes can represent estimates for shoreline management denitrification.

The studies used for the panel's denitrification protocol are provided in Table 24 and were condensed to represent one value per study as provided in Table 25. See *Section 5.1.2 Tidal Marsh Denitrification* for more information.

Table 24. Denitrification literature summary.

Study Area	Denitrification Rate	Nearshore Water Characteristics	Sample Time	Sample Location	Site and Drainage Characteristics	Notes	Method[1]	Source
Dyke Marsh, Potomac River (VA)	147 µmol N m^{-2} h^{-1}	Tidal freshwater	November	Annual, mixed, and perennial plant community type	Dyke Marsh Preserve is a 80 ha marsh on the Potomac River and located south of Alexandria, VA	Mean DNR[2] rates	MIMS	Hopfensperger et al., 2009
Dyke Marsh, Potomac River (VA)	147 µmol N m^{-2} h^{-1}	Tidal freshwater	October	High, mid, and low marsh	Dyke Marsh Preserve is a 80 ha marsh on the Potomac River and located south of Alexandria, VA	DNR listed in Table 4	MIMS	Hopfensperger et al., 2009
Jug Bay NERRS, Maryland	60 µmol N m^{-2} h^{-1}	Tidal freshwater	Spring	High, mid, and low marsh	Patuxent River catchment	NA	MIMS	Merrill and Cornwell, 2000
Jug Bay NERRS, Maryland	28 µmol N m^{-2} h^{-1}	Tidal freshwater	Fall	High, mid, and low marsh	Patuxent River catchment	NA	MIMS	Merrill and Cornwell, 2000
Jug Bay Wetlands Sanctuary, Maryland	120 µmol N m^{-2} h^{-1}	Tidal freshwater	April through October	High, mid, and low marsh		DNR reported was the grand mean of all rates measured	MIMS	Greene, 2005

Patuxent River, Maryland	38 µmol N m^{-2} h^{-1}	Subtidal freshwater	Annual average	High marsh	Patuxent River estuary (Patuxent basin is 2,256 km^2)	DNR rates reported in Table 5 were weighted for spatial variation	N_2 flux	Boynton et al., 2008
Patuxent River, Maryland	32 µmol N m^{-2} h^{-1}	Subtidal freshwater	Annual average	Low marsh	Patuxent River estuary (Patuxent basin is 2,256 km^2)	DNR rates reported from Table 5 were weighted for spatial variation	N_2 flux	Boynton et al., 2008
Patuxent River, Maryland	110 µmol N m^{-2} h^{-1}	Tidal freshwater	Annual average	High marsh	Patuxent River estuary (Patuxent basin is 2,256 km^2)	DNR rates reported from Table 5 were weighted for spatial variation	N_2 flux	Boynton et al., 2008
Patuxent River, Maryland	80 µmol N m^{-2} h^{-1}	Tidal freshwater	Annual average	Low marsh	Patuxent River estuary (Patuxent basin is 2,256 km^2)	DNR rates reported from Table 5 were weighted for spatial variation	N_2 flux	Boynton et al., 2008
Patuxent River, Maryland	60 µmol N m^{-2} h^{-1}	Tidal freshwater	Summer	High, mid, and low marsh	Patuxent River catchment	Annual net DNR in marsh sediments	MIMS	Merrill, 1999
Narragansett Bay, Rhode Island	420 µmol N m^{2} hr^{-1}	Tidal saltwater	June to August	High marsh	Watershed to marsh surface area were 3.4, 6.2, 574, 151, and 201	Five fringe marshes sampled; high range DNR reported	MIMS	Davis et al., 2004

West Creek Plum Island, Sound Estuary, Massachusetts	494 µmol N m^2 d_{-1}	Tidal saltwater	August	High marsh (low edge)	Unfertilized West Creek, reference sites	Estimated total daily denitrification rates in tidal creek and marsh platform sediment	DNRA	Koop-Jakobsen and Gibllin, 2010
West Creek Plum Island, Sound Estuary, Massachusetts	428 µmol N m^2 d_{-1}	Tidal saltwater	July	High marsh (low edge)	Unfertilized West Creek, reference sites	Reference and July for marsh platform DNR reported	DNRA	Koop-Jakobsen and Gibllin, 2010
Choptank River, Maryland	123 µmol N m^{-} $_{2}$ h_{-1}	Tidal brackish	July and August	Low marsh	Choptank River catchment	Upstream on the Choptank River	MIMS	Kana et al. (1998)
Choptank River, Maryland	50 µmol N m^{-2} h_{-1}	Tidal brackish	July and August	Low marsh	Choptank River catchment	Downstream on the Choptank River	MIMS	Kana et al. (1998)
Choptank River, Maryland	60 µmol N m^{-2} h_{-1}	Tidal brackish	July and August	Low marsh	Choptank River catchment	Intercept with no nitrate to fuel nitrification	MIMS	Kana et al (1998)
Ringfield Marsh on the King Creek/York River, Virginia	2.75 mmol N m_{-2} h_{-1}	Tidal mesohaline	May and October	High and Low marsh	Colonial National Historical Park on the Ringfield Peninsula near King Creek and the York River	Fringe marsh; average DNR reported from Table 3	DNRA	Tobias et al., 2001

Ringfield Marsh in the York River, Virginia	0.83 mmol N m^{-2} h^{-1}	Tidal mesohaline	May and October	High and Low marsh	Colonial National Historical Park on the Ringfield Peninsula near King Creek and the York River	Fringe marsh; Average DNR reported from Table 3	DNF	Tobias et al., 2001

[1]The method acronyms used include:

- MIMS is membrane inlet mass spectrometry.
- DEA is denitrification enzyme activity.
- DNF is the potential denitrification.
- DNRA is the potential dissimilatory nitrate reduction to ammonium. [2]DNR is denitrification.

Table 25. Denitrification literature summary that was condensed to represent one value per study.

Value	Units	Source
147	µmol N m^{-2} h^{-1}	Hopfensperger et al., 2009
44	µmol N m^{-2} h^{-1}	Merrill and Cornwell, 2000
120	µmol N m^{-2} h^{-1}	Greene, 2005
65	µmol N m^{-2} h^{-1}	Boynton et al., 2008
60	µmol N m^{-2} h^{-1}	Merrill, 1999
420	µmol N m^{-2} h^{-1}	Davis et al., 2004
19.1	µmol N m^{-2} h^{-1}	Koop-Jakobsen and Gibllin, 2010
78	µmol N m^{-2} h^{-1}	Kana et al,1998
3165	µmol N m^{-2} h^{-1}	Tobias et al., 2001
77.67	**µmol N m^{-2} h^{-1}**	**median**
85.02	**pounds N/acre/year**	**median**

Appendix I. Sedimentation Data

The scientific review supports accretion and sedimentation as a sediment and phosphorus removal mechanism. The sediment accretion literature summary is provided in Table 26. Brief summaries of the reviewed studies are presented here:

- Loomis and Craft (2010) in a study of freshwater, brackish, and salt marshes in Georgia found marsh accretion rates of 7.78 mm/yr (tidal fresh), 4.41 mm/yr (brackish marshes), and 1.91 mm/yr (salt marshes). The associated nitrogen accumulation was 8.2 g m^{-2} yr^{-1} (tidal fresh), 6.5 g m^{-2} yr^{-1} (brackish), and 2.4 g m^{-2} yr^{-1} (salt marshes). The phosphorus accumulation was 0.7 g m^{-2} yr^{-1} (tidal fresh), 1.0 g m^{-2} yr^{-1} (brackish), and 0.3 g m^{-2} yr^{-1} (salt marshes). The study utilized ^{137}Cs core analysis to determine accretion rates.
- Smith, et.al. (2013) using cores and ^{210}Pb and ^{137}Cs analysis from interior tidal fresh and brackish marshes in the Mobile Bay developed two models (constant flux-constant supply (CF:CS) and a constant rate of supply model (CRS)) to determine sedimentation rate and mass accumulation rate. The results varied both by the marsh type and the model used. Tidal freshwater sites had a sedimentation rate between 0.657 cm yr^{-1} (CF:CS model) and 0.907 cm yr^{-1} (CRS model), while brackish marshes had a sedimentation rate between 0.498 cm yr^{-1} (CF:CS model) and 0.461 cm yr^{-1} (CRS model). The corresponding mass accumulation rates were: tidal freshwater between 0.834 g cm^{-2} yr^{-1} and 0.587 g cm^{-2} yr^{-1}; brackish 0.529 g cm^{-2} yr^{-1} and 0.335 g cm^{-2} yr^{-1}.
- Currin, et.al. (2008) studied natural and restored fringing salt marshes in North Carolina. A total of 3 paired sites were included in the study, with multiple samples from each site (89 natural site samples, 154 restored site samples). A number of parameters were monitored, including; surface elevation, vegetation, and nekton. The elevation changes were measured at two of the sites for both natural and restored marshes (Site 1: Natural marsh average change = 7.48 cm (n=21), restored = 9.32 cm (N=19); Site 2: Natural marsh average change = 11.78 cm (n=12), restored = 23.96 cm (N=23)). The authors concluded that the accretion rates of restored marshes were 1.2 to 2.0 times greater than natural marshes. Other conclusions of the study include: percentage cover and stem height were significantly lower in restored versus natural marshes; after three years the restored marshes achieved stem densities equivalent to natural fringing marshes. There was no difference in the mean number of fish and crabs or shrimp between natural and restored fringing marshes, but there were some differences when individual species were considered.
- Anisfeld, et.al. (1999) analyzed sedimentation rates in natural, flow-restricted and restored salt marshes in Long Island Sound using ^{137}Cs and ^{210}Pb core dating. The mean vertical accretion rates varied between marsh type and core dating method. The ^{137}Cs dating method resulted in higher accretion rates than the ^{210}Pb. Using the ^{137}Cs method the average accretion rates were: natural = 0.37 cm yr^{-1}, restricted = 0.29 cm yr^{-1}, and restored = 0.66 cm yr^{-1}. The bulk of the accretion was due to inorganic sediment with organic matter equal to 8.4%, 7.2%, and 5.2%, respectively. The equivalent average mass accumulation rate was:

natural = 1020 g m^{-2} yr^{-1}, restricted = 1200 1020 g m^{-2} yr^{-1}, and restored = 1320 1020 g m^{-2} yr^{-1}.

- Chmura, et.al. (2001) studied salt marsh accretion rates in the outer Bay of Fundy using ^{137}Cs and ^{210}Pb core methodology along with pollen stratigraphy to estimate changing accretion rates over time. Average marsh accretion rates ranged from 1.3 to 4.4 mm yr^{-1} over the last two centuries. Recent rates are in-step with local sea level change. Rates were higher in the late 18th and early 19th century than present, which may have been due to local tectonic activity and ice rafting.
- Vogel, et.al. (1996) studied sediment accretion using ^{137}Cs and ^{210}Pb core dating in the North Inlet Marsh in South Carolina. They also used suspended sediment flux analysis and discharge modeling in their study. They the results from three cores indicated the material was 80% inorganic. The three cores had accretion rates of 2.9, 3.5, and 1.6 mm yr^{-1}, which is calculated to be an inorganic accumulation of 0.091, 0.097, and 0.046 g cm^{-2} yr^{-1}.
- Cavatorta, et.al. (2003) studies marshes in the Parker River estuary in northeastern Massachusetts through a combination if aerial photography, TSS sampling, and sediment traps along transects deployed for two tidal cycles. Sediment accumulation ranged from 0.025 to 0.5 g per 9 cm^2 filter. They concluded that due to the lack of TSS in the system that the below ground plant production may be more important than sedimentation in marsh accretion in this system.
- Strange (2008) summarized accretion rate studies from the Virginia eastern shore, with a low of 0.9 mm yr^{-1} to a high of 2.1 mm yr^{-1}.
- White and Howes (1994) studied nitrogen pathways in the Great Sippewissett Marsh, Massachusetts. They determined burial rates of 3.7 – 4.1 g N $m^{-2}yr^{-1}$. They concluded that long-term N retention appears to be controlled primarily by the competition for DIN between plants and bacterial nitrifiers-denitrifiers and secondarily by the relative incorporation of N into aboveground vs. belowground biomass.
- Bragadeeswarean, et.al. (2007) sampled sediment for physical composition and nutrients at three stations over two years in the Arasalar estuary, India. Nitrogen was found to have a mean range of 2.83 – 3.37 mg/g sediment and phosphorus to have a mean range of 0.07 – 0.18 mg/g sediment.
- Morgan, et.al. (2009) studied fringing salt marshes in Casco Bay, Maine for ecological functions and values. They found mean accumulation values from 2.24 g m^2 day^{-1} to 9.82 g m^2 day^{-1}. They found accretion rates of 0 to 6.3 mm/yr.
- Jordan, et.al. (1986) found in a study of the Rhode River estuary in the Chesapeake Bay that influx of particulate matter to marshes is directly related to the amount of time they are submerged during tidal cycles. They found a mineral deposition rate of 2,800 g m^{-2} yr^{-1} for subtidal areas, 400 g m^{-2} yr^{-1} low marsh, and 200 g m^{-2} yr^{-1} for high marsh.
- Calloway, et.al. (2012) studied two marshes in San Francisco Bay using transect coring and marker horizons to determine long-term and short-term.

Table 26. Sediment accretion literature summary.

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate ($g/cm^2/year$)		Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
North Carolina – fringing marsh restoration and natural	7.48 cm 9.32 cm 11.78 cm 23.96 cm			266,943 332,604 420,395 855,064	Elevation Change - Survey	Fringing marsh - polyhaline	Spring (April) Fall (Sept. or Oct)	Natural Restored Natural Restored	These are fringing marshes, restored marshes 1.5 – 2.0 fold greater sediment accretion rates.	Currin, et.al., 2008
North Carolina – North Inlet Salt Marsh	2.9 mm 3.5 mm 1.6 mm	0.1141 0.1213 0.0580		10,180 10,822 5,175	^{210}Pb	Estuarine salt marsh	NA coring	Average bulk density 0.4 g/cm^3	80% inorganic matter, seasonal variation	Vogel, et.al., 1996
Massachusetts – Parker River Estuary		0.05 $g/9cm^2/21$ days 0.025 $g/9cm^2/21$ days		8,615 4,307	Sediment trapping of filters	Estuarine salt marsh	July, 2003; two sets of samples exposed over several spring tide cycles.	Inorganic sediment numbers	This high level, low level interpreted from graph is 0.025.	Cavatorta, et.al., 2003
Connecticut – Long Island Sound	Reference 0.25 cm 0.42 cm 0.42 cm 0.33 cm 0.44 cm 0.34 cm Restricted 0.38 cm 0.19 cm 0.39 cm	IM* 160 750 760 630 1000 780 1200 470 1800	OM* 290 360 400 250 300 430 240 170 390	 1,428 6,691 6,781 5,621 8,922 6,959 10,706 4,193 16,059	^{137}Cs, ^{210}Pb	Salt marshes, both natural and restored		Bulk density varies with depth for restricted sites, but not reference or restored. Ref max = 0.4 g/cm^3 Res max = 0.84 g/cm^3	This study looked at accretion rates in reference marshes, marshes with flow restrictions, and marshes with flow restrictions eliminated. The accretion was partitioned between inorganic (sediment) and organic material. The study also included pore space volume as part of the	Anisfeld, et.al., 1999

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate ($g/cm^2/year$)		Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
	0.31 cm 0.25 cm 0.25 cm Restored 0.63 cm 0.69 cm	1000 1100 180 760 1100	210 130 230 380 380	8,922 9,814 1,606 6,781 9,814					accretion (dominated the accretion rate). Also looked at carbon accretion and nitrogen accretion. Burial of nitrogen in marsh sediments is a semi-permanent sink.	
									Review paper of salt marsh fluxes. Insufficient numerical data to be of use for our purposes.	Fagherazz et al., 2013
Maine/Canada (New Brunswick) – Bay of Fundy	1.6 mm 1.4 mm 1.6 mm			5,710 4,996 5,710	^{137}Cs, ^{210}Pb Pollen Stratigraphy	3 Coastal salt marshes	NA cores			Chmura, et.al. 2001
South Carolina									Study looked at sediment and metal mobilization during low tide rainfall events, not applicable, except as another process to consider, but should be covered by looking at long term accretion rates.	Chen et.al., 2012
California – San Francisco Bay	Corte Madera 0.49 cm 0.38 cm 0.49 cm	IM* 2056. 5 1631. 9	OM* 303.9 261.8 372.7 212.3	 18,348 14,559 19,194 5,886	Sediment Pads, Marker Horizons,	Natural salt marsh, and old restored	Pads, 2-week period every 3 months, for 1 year; Markers –	 Tran A – Low Tran B – Low Tran A- Mid Tran B – Mid	Study used sediment cores with isotope dating for long term analysis, and sediment pads for short term analysis and fractionation into	Callaway, et al., 2012

Study Area	Trapping Rate – Vertical accretion (cm/year)		Trapping Rate (g/cm²/year)		Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
	0.32 cm 0.36 cm 0.36 cm Based on ^{137}Cs analysis		2151.4 659.8 1109.2 1034.2	242.7 260.7	9,896 9,9227	and ^{137}Cs, ^{210}Pb	salt marsh	quarterly measurement for 1.5 years.	Tran A –High Tran B - High	inorganic and organic material. Measured bulk density of 10cm segments of cores	
Alabama – Mobile Bay	CF:CS 0.158 0.797 0.290 0.706 1.480 0.085	CRS 0.755 1.058 0.330 0.592 1.153 ND	CF:CS 0.457 1.210 0.086 0.972 0.758 0.08	CRS 0.336 0.838 0.095 0.575 0.370 ND		^{137}Cs, ^{210}Pb	3 different marsh types; freshwater, interior brackish, fringing brackish.	NA cores	Freshwater Freshwater Interior Interior Fringing Fringing	Six cores representing 3 different marsh types; freshwater, interior brackish, fringing brackish. Used two models to determine rate; constant flux-constant supply (CF:CS) and Constant rate of supply (CRS). No distinct patterns among marsh types.	Smith, et al., 2013
North Carolina – Albemarle Sound						^{137}Cs, ^{210}Pb	Open Water		Not applicable to marsh deposition	Open water deposition, not marsh deposition	Corbett, et al., 2007

California – Mugu Lagoon		Range 0-1.29*						Measured three parameters, TSS, sediment deposition, vertical accretion, short term study February - April	Rosencranz, 2012

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate ($g/cm^2/year$)	Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
Tidal freshwater marsh in VA	8.4 to 8.5 cm/yr (84 to 85 mm/yr)		29,977 30,334	Cesium 137	High vegetation and low urbanization in watershed		Are the units reversed or should the cm measurements be .84 and .85?? **Need to Check Units**	Used .84 and .85 cm/year for calculations	Neubauer et al, 2002
Jug Bay NERRS, Maryland	0.2 cm/yr (Harrison and Bloom, 1974) to 1.35 cm/yr (DeLaune et al, 1981) 250 cm/yr (25 mm/yr) to 11 cm/yr (1.1 mm/yr)		7,137 48,178				Ranges of vertical accretion reported in the literature as cited by Merrill and Cornwell	p. 426	Merrill and Cornwell, 2002

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate (g/cm²/year)	Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
Patuxent River, Maryland	0.21 (tidal marsh), 0.27 (subtidal estuary), 0.21 (tidal marsh) and 0.11 (subtidal marsh)			Pb 210				Values from Table 6 converted from g dry sediment/m2-yr (p. 641)	Boyton et al., 2008

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate ($g/cm^2/year$)	Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
New England		0.073 to 1.10 g/cm2-yr (2 to 30 g/m2-day)	6,513 to 97,694		Fringe salt marsh		- Sediment trapped at edge of marsh: 2-30 g/m2/day Slightly - more sediment trapped in fringe marshes than meadow marshes (but not significant		Morgan et al., 2009

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate (g/cm²/year)	Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
Blackwater		-1.38 g/cm2-yr (-13.8 kg/m2yr)	-123,121				- Blackwater as a whole is not trapping sediment, unlike what is believed by marsh systems - Blackwater marshes are losing sediment at a rate of 13.8 kg/m2/yr - Any accretion that is occurring is biological, not the accumulation of sediment (but these are not fringe marshes, which is what living shorelines would be, and Morgan et al finds that marshes trap sediment at the edges) -	- He does find that little sediment is trapped beyond 3m into the marsh (so edge is important, and again, what we're building with LS is edge/fringe marshes) - Different marshes in different areas (e.g., riverine marshes in the turbidity maximum of rivers vs. submerged upland marshes) perform differently for sediment removal. Therefore, sediment removal of LS might depend on where you put the LS project	Stevenson et al., 1985

Study Area	Trapping Rate – Vertical accretion (cm/year)	Trapping Rate (g/cm^2/year)	Pounds Sediment/ Acre/Year	Study Method	Marsh Type	Study Timeframe	Notes	Comments	Source
Dyke Marsh Wildlife Preserve (Potomac)		0.44±0.29 on elevated banks 0.27±0.24 rest of marsh Data also shows seasonality in deposition	39,256 24,089	Tilederived sedimentation	Tidal fresh	April 2010 to September 2011	-	-	Palinkas, et al., 2013
Dyke Marsh Wildlife Preserve (Potomac)		0.46±0.18 on elevated banks 0.41±0.29 rest of marsh Data also shows seasonality in deposition	41,040 36,579	Berilium-7	Tidal fresh		-	-	Palinkas, et al., 2013
Corsica River		0.3 to 1.89 in the marsh	26,765 168,622	210Pb verified with 137Cs			-	-	Palinkas and Cornwell 2012
North Carolina		0.021 to 0.036 g/m^2/yr (21 to 36 kg/m^2/yr)	0.19 0.32	1) Feldspar marker layers and 2) fine particles in surface soil (p. 1420)	Constructed salt marsh	October 1998 to Marsh 1999	Random samples that were from streamside and from marsh interior from eight marsh systems	Constructed S. alterniflora marsh 1 to 3 years old	Craft et al., 2003

North Carolina		0.002 $g/m^2/yr$ (2 $kg/m^2/yr$)		.02		Feldspar marker layers and 2) fine particles in surface soil (p. 1420)	Constructed salt marsh	October 1998 to Marsh 1999	Random samples that were from streamside and from marsh interior from eight marsh systems	Natural reference marsh	Craft et al., 2003
Louisiana, Mississippi Delta		IM	OM	IM	OM	^{137}Cs		NA			Nyman, et al., 2006
	.59	1,928	424	17,201	3,783		Saline				
	.88	1,270	604	11,331	5,389		Brackish				
	.10	374	538	3,337	4,800		Fresh				
	.24	1,970	618	17,576	5,514		Saline				
	.12	724	542	6,459	4,836		Brackish				
*g/m^2/year											

Appendix J. Marsh Redfield Ratio Data

The rationale for a marsh Redfield ratio protocol was based on the vegetation's aboveground and belowground productivity (Table 27). When the shoreline management practice includes the creation of new intertidal vegetated wetlands/plants, with or without any associated structure, the "start-up" of the new marsh will result in a net uptake of nutrients. This is based upon several well-understood natural and construction processes (Davis et al., 2008; Currin et al., 2010). Tidal marshes have high levels of primary productivity. In addition, the new created marshes are generally created using clean sand fill and planted bare root vegetative sprigs. This means that created marshes contain low levels of nutrients. If fertilized, which is a common practice, the slow-release nutrients are used by the new marsh plants to help overcome the lack on in-situ nutrients.

Vegetative biomass in natural marshes is generally split evenly between aboveground and belowground material (Schubauer and Hopkinson, 1984). Assessments of primary production and vegetative cover of newly planted tidal marshes indicate growth and mimic natural marshes at around year five (Craft et al., 2003). Therefore, prior to achieving this level of primary production, the plants in the systems are taking up nutrients and carbon. Much of the biomass of this initial growth is found belowground in the roots and rhizomes as the plants started as bare root springs. The nutrients that support the initial grow-out are removed from the waterway and become a reduction in nutrient load. The following studies were used to determine the Marsh Redfield Ratio.

Table 27. Marsh vegetation aboveground and belowground productivity literature summary.

g dry matter m^{-2} yr^{-1}	Location	Source
2,883	GA	Odum and Fanning (1973)
812.5	NC	Stroud and Cooper (1969)
2,683	GA	Odum and Fanning (1973)
2,658	LA	Hopkinson et al (1978
973	GA	Smalley (1958
2,650	GA	Odum 1959 and Odum (1961
862.5	NC	Stroud and Cooper (1969
650	NC	Williams and Murdoch (1969
1,000	NC	Williams and Murdoch (1969
1,335	VA	Wass and Wright (1969
2,800	NJ	Smith et al. (1979)
1,487	NJ	Roman and Daiber. (1984
5,250	MA	Valiela et al. (1976
6,043	LA	Hopkinson et al. (1978)
1,428	LA	White et al. (1978)

g dry matter m^{-2} yr^{-1}	**Location**	**Source**
1,296	NC	Waits (1967)
1,147	NJ	Roman and Daiber (1984)
993	NY	Harper (1918)
1,335	LA	Hopkinson et al. (1978)
3,237	LA	Hopkinson et al. (1978)
9,162	LA	White et al. (1978)
855	VA	Mason (1989)
1,600	MS	de la Cruz (1974)
2,100	GA	Gallagher and Plumley (1979)
500	NC	Stroud (1976)
350	NC	Cammen (1975)
2,900	NJ	Good (1977)
3,300	NJ	Good and Frasco (1979)
490	NJ	Roman and Daiber (1984)
1,120	NJ	Smith et al. (1979)
3,500	MA	Valiela et al. (1976)
329	VA	Mason (1989)
900	MS	de la Cruz (1974)
310	GA	Gallagher and Plumley (1979)
470	DE	Gallagher and Plumley (1979)
3,270	NJ	Good and Frasco (1979)
2,500	MA	Valiela et al. (1976)
2,200	MS	de la Cruz and Hackney (1977)
3,560	GA	Gallagher and Plumley (1979)
1,070	GA	Gallagher and Plumley (1979)
3,400	DE	Gallagher and Plumley (1979)
2,780	NJ	Good and Frasco (1979)
420	VA	Mason (1989)
2,000	GA	Gallagher and Plumley (1979)
1,458		**Median**

Appendix J References for Table 27:

Cammen, L. M. 1975. Accumulation rate and turnover time of organic carbon in a salt marsh sediment. Limnology and Oceanography 20: 1012–1015.

de la Cruz, Armando A. 1974. Primary productivity of coastal marshes in Mississippi. Gulf Research Reports 4: 351-356.

de la Cruz, Armando A. and Courtney T. Hackney. 1977. Energy value, elemental composition, and productivity of belowground biomass of a *Juncus* tidal marsh. Ecology 58.5: 1165-1170.

Gallagher, J.L. and Plumley F.G. 1979. Underground biomass profiles and productivity in Atlantic coastal marshes. American Journal of Botany 66(2): 156-161.

Good, R. E., and B. R. Frasco. 1979. Estuarine evaluation study; a four year report on production and decomposition dynamics of salt marsh communities: Manahawkin marshes, Ocean County, New Jersey. Report to New Jersey Department of Environmental Protection, Division of Fish, Game, and Shellfisheries. Trenton, New Jersey.

Good, R.E. 1977. An environmental assessment of the proposed reconstruction of State Route 152 (Somer Point-Longport) Atlantic County, New Jersey. Report to E. Lionel Pavlo Engineering, New York, NY. 41 p.

Harper, R.M. 1918. Some dynamic studies of Long Island vegetation. Plant World 21: 38-46.

Hopkinson, Charles S., James G. Gosselink, and Rolando T. Parrando. 1978. Aboveground production of seven marsh plant species in coastal Louisiana. Ecology: 760-769.

Mason, P. A., & College of William and Mary. School of Marine Science. 1989. The standing stock of organic matter in a man-made brackish marsh and its resource management implications (Master's thesis).

Odum, E.P. 1959. Fundamentals of Ecology. McGraw-Hill. New York, New York.

Odum, E.P. 1961. The role of tidal marshes in estuarine production. *In* The conservationist. New York State Conservation Department. Albany, New York.

Odum, E. P. and M. Fanning. 1973. Comparison of the productivity of *Spartina alterniflora* and *Spartina cynosuroides* in Georgia coastal marshes. Bulletin of the Georgia Academy of Science 31: 1-12.

Roman, Charles T. and Franklin C. Daiber. 1984. Aboveground and belowground primary production dynamics of two Delaware Bay tidal marshes. Bulletin of the Torrey Botanical Club: 34-41.

Smalley, Alfred Evans. 1958. The Role of Two Invertebrate Populations: *Littorina Irrorata and Orchelimum Fidicinum,* in the Energy Flow of a Salt Marsh Ecosystem. Dissertation. University of Georgia. Athens, Georgia.

Smith, K. R. Good, and N. Good. 1979. Production dynamics for above and belowground components of a New Jersey *Spartina aterniflora* tidal marsh. Estuarine, Coastal and Marine Science 9: 189-201.

Smith, Thomas J., III and William E. Odum. 1981. The effects of grazing by snow geese on coastal salt marshes. Ecology 62(1): 98-106.

Stroud, Linda Mills. 1976. Net primary production of belowground material and carbohydrate patterns of two height forms of *Spartina alterniflora* in two North Carolina marshes. Ph.D. dissertation. North Carolina University. Raleigh, North Carolina.

Stroud, Linda M., and Arthur W. Cooper. 1969. Color-infrared aerial photographic interpretation and net primary productivity of a regularly-flooded North Carolina salt marsh. Dissertation at the North Carolina State University. Raleigh, North Carolina.

Valiela, Ivan, John M. Teal, and Norma Y. Persson. 1976. Production and dynamics of experimentally enriched salt marsh vegetation: belowground biomass. Limnology and Oceanography 21.2: 245-252.

Waits, E. D. 1967. Net primary productivity of an irregularly-flooded North Carolina salt marsh. Ph.D. Thesis. North Carolina State University. Raleigh, North Carolina.

Wass, Marvin L. and Thomas D. Wright. 1969. Coastal Wetlands of Virginia-Interim Report of the Governor and General Assembly. A summary of Special Report in Applied Marine Science Ocean Engineering No. 10. Virginia Institute of Marine Science. Gloucester Point, Virginia.

White, David A., T. Edward Weiss, John M. Trapani, and Leonard B. Thien. 1978. Productivity and decomposition of the dominant salt marsh plants in Louisiana. *Ecology* : 751-759.

Williams, Richard B. and Marianne B. Murdoch. Potential importance of *Spartina alternifora* in conveying zinc, manganese and iron into estuarine food chains. Bureau of Commercial Fisheries Beaufort, NC Radiobiological Laboratory. Beaufort, North Carolina.

Appendix K. Sediment Sampling Protocol

Sediment Sampling Protocol

Eroding bank sediments have been identified as a source of nitrogen and phosphorus. Nutrients are contained within and attached to the eroding sediment. Ibison et al. (1990 and 1992), analyzed numerous bank sediments to develop a general sense of nutrient loading to the Bay via eroding bank sediments. The sampling method performed for these studies was to approach the subject eroding bank and acquire fresh samples along the bank face that represent each notable change in strata.

The goal of bank sampling is to acquire sediments along the exposed bank face in order to determine the amount and proportion of gravel, sand, silt and clay that is being eroded into Chesapeake Bay for a particular segment of shoreline. Along with grain size the amount of TN and TP need to be analyzed in the context of the volume and rate of eroded material. Once acquired from the field the grain size and nutrient analyses outlined in the Ibison et al (1990 and 1992) reports should followed.

Methods

One may start at the top or bottom of an exposed and eroding bank face but it is important to keep track of elevation above some reference point. Establishing approximate MHW is a good start. One needs to perform a rudimentary site assessment in order to determine if only on bank sampling transect is needed. Long sites with varying alongshore lithology and stratigraphic faces may require more than one sample transect. Higher banks become more difficult not only because it takes more time and gets dangerous but slumping may cover part of the outcrop along the bank face and base and digging for the *in situ* strata becomes important. Taking a continuous vertical transect may also be difficult so moving up or down river along the bank face may be required to reach a “fresh” outcrop. This is fine as long as the alongshore strata does not change significantly. The important thing is to keep track of the elevation of the samples.

Sampling from the bottom up may require digging steps into the bank as you sample up. Using repelling gear going top to bottom will also help especially on the higher banks. Ladders can work on intermediate banks (20 to 30 feet) if they are very steep approaching vertical but there should be two people for this work. Other gear should include a stadia rod (or equivalent), a hand level, sample bags (Whirl Paks TM) and sampling tools. These could include trenching tools, metal scoops, or other digging and scraping devices.

The exposed bank face needs to be "cleared" to expose a fresh swath of strata. Using the side of a trenching tool works great for this and the point shovel can be used to take samples. One can take spot samples or channel samples or some combination as long as the samples best represent the exposed strata. The channel sample method takes samples along the bank face as one tries to take a consistent amount of material along the vertical extent of the channel. This is much easier in sands and silty sands than hard silts or fat clays. The goal is to sample each different strata somewhat equally so the results can be applied appropriately to the overall eroded volume of the bank. Do not sample across significant stratigraphic boundaries like the one between sands and clays. At this point, it is still important to relate grain size to nutrients even though the whole section is eroded away over time.

It is important to keep track of the sampling exercise by taking copious field notes. After the samples are taken they should be placed in a cooler and sent to the lab for analyses.

Analysis

Refer to Ibison et al. (1992 and 1990).

This sampling method was developed by Scott Hardaway (2013).

Appendix L. Dissenting View Document

This dissenting view document was compiled and vetted by the following Shoreline Management panelists:

- Kevin Smith, MD DNR
- Jana Davis, CBT
- Pam Mason, VIMS
- Jeff Halka, MGS retired
- Eva Koch, UMCES
- Lee Karrh, MD DNR

Chesapeake Bay Program
Shoreline Management
Expert Panel
Dissenting View

April 3, 2014

The Shoreline Management Expert Panel met from January 2013 to March 2014, charged with quantifying the nitrogen, phosphorus, and sediment load reductions resulting from shoreline erosion control practices. The resulting panel report represents the majority view; however, significant dissent (40 % of the panel) characterized several of the main findings. The purpose of this dissenting view is to summarize the areas of dissent and describe its logic such that those reviewing the report, including various Bay Program committees and boards as well as the general public, can be aware of the issues. This dissenting document focuses on the science and the outcomes; however, some comments on the panel process are offered that may help inform adaptive management of the panel process by the Bay Program in the future.

Summary of the Report and the Dissent

The panel report describes four types of credit that can be earned by shoreline erosion control practices:

1) sediment and nutrients eroding from the bank immediately upland of the practice, termed "prevented sediment;"
2) sediment and nutrients captured through trapping sediment from the water column through contact with water through tidal action,
3) denitrification occurring in the wetlands created through living shorelines; and 4) nutrients bound through uptake by the plants used in a living shoreline.

The dissent focused entirely on the first type of credit: prevented sediment, which provides the bulk of the credit a typical shoreline management project would be awarded.

The two underlying principles serving as the basis for most of the dissent were:

a) the treatment of sediment in the Chesapeake Bay Watershed Model (CBWM), in which sediment reduction credit is given across sediment grain sizes; for example, from finegrained sediments emanating from upland construction sites (known to have adverse impacts on factors such as water quality) as well as naturally eroding large-grained sand particles from a bay-front cliff, (known to create wetland and SAV habitat),
b) the narrow focus of the panel's charge on nutrients and sediment rather than an ecosystem approach, resulting in potential unintended consequences to other natural resources.

Sediment types: Not all sediment is "bad"
Shoreline erosion is a natural geologic process, experienced by shorelines of all estuaries worldwide, balancing such global forces as tectonic uplift (mountain ranges constantly erode, and sediments are carried down rivers) and sea level rise due to glaciation. Sediments, especially large-grained sediments, eroding from shorelines serve many important geologic and ecological functions, including supplying sediment that supports submerged aquatic vegetation (SAV) beds; wetlands; unvegetated beach habitat important for species like horseshoe crabs and terrapin; and dynamic sand spits and other similar features that protect low energy coves, which, in turn can be important habitat for seabirds and other wildlife (e.g., Kirwan and Megonigal, 2013). In fact, previous workshops and committees convened by the Chesapeake Bay Program have recognized the ecosystem value of eroding shorelines (Chesapeake Bay Program, 2005; Chesapeake Bay Program, 2006). Turning off that sediment supply with shoreline erosion control practices, whether "green practices" (e.g., living shorelines) or traditional hard armor, can interrupt the sediment budget for a region, negatively affecting SAV (Palinkas and Koch, 2012), wetland, and other habitat. Additionally, Patrick et al (in press) demonstrated negative impacts to SAV distribution when more than 5.4% of the shoreline has stone structures in a watershed, as identified by the 2006 VIMS Shoreline Inventory (which did not differentiate between revetment and sill). Solving one problem, as was the focus of this panel's charge, can cause an even greater problem in other natural resources.

This report attempted to manage this issue by only giving credit for the portion of prevented sediment that is fine -grained. To accomplish this, the total volume of sediment that was prevented from entering the system through the installed practice was multiplied by the percentage of the fine-grained sediments estimated to be present in the bank. However, while this approach does not give credit to prevention of the coarse-grained sediment, it still encourages its loss into the system by not providing a negative incentive. Preventing the finegrained sediment from eroding, which may be a positive, should be balanced by prevention of the coarse-grained sediment from eroding, which is a negative. In the formula used, the positive outcomes are provided credit but the negative ramification is ignored.

<u>Solution:</u> <u>The dissenting group on the expert panel therefore are of the opinion that protocol 1 in the report, which provides credit for prevented sediment, should be removed.</u>

Focus on nutrients and sediment rather than ecosystem approach: Credit for armor

In the expert panel report, qualifying conditions are articulated in which nutrient and sediment credit can be earned for hard shoreline armor (conventional erosion control), such as bulkheads and on-shore stone revetments, particularly in cases in which living shorelines are not possible. Some on the panel felt that given what we know about impacts of such conventional armor on fish habitat, SAV habitat, and other resources, there should never be a credit offered to armor. Armor in estuaries generally removes the shallowest areas of habitat available, often removing the entire range considered to be refuge habitat (Jennings et al. 1999, Peterson et al. 2000, Bilkovic et al 2006, Davis et al 2008, Palinkas and Koch 2012, Patrick et al. in press). Armor may exhibit chemical differences or leach toxic chemicals (Weis et al. 1998). Armor can disrupt both chemically and biologically the land-water interface (Jennings et al. 1999). As a result of all of these factors, armored sites generally have lower species diversity of motile macrofauna and infauna, lower densities, and differences in body size (e.g., Peterson et al. 2000; Bilkovic and Roggero 2008, Davis et al. 2008; Long et al. 2011)

Armor in certain cases may be unavoidable or the only management solution, such as in highly developed port facilities or in areas in which toxic sediments are prevented from entering a waterway. This dissenting statement acknowledges that such armor should be used as a management option in some cases. However, the question is whether such practices should be allowed to receive sediment reduction credit in the bay model.

Solution: Given the negative impacts on other natural resources also managed by the Bay program, such as SAV, wetlands, fishes, and more, the dissenting group on the expert panel hold the opinion that while armor may be permitted by regulatory agencies in some cases, it should not be provided sediment or nutrient credit.

Management ramifications

The outcome of the expert panel report is such that shoreline erosion control projects in some cases will be calculated to provide as much if not more than the reduction credit for nitrogen, phosphorus, and sediment per linear foot than stream restoration or stormwater practices like bioretention cells. As a result, the costs may be less expensive per pound of pollutant relative to stream restoration or stormwater management practices. Such differences are likely to drive management choices by local jurisdictions charged with meeting total maximum daily load targets (TMDLs), even though these sources of nutrients and sediment are not a direct result of human activity but are instead a natural process. Ecologically and from a larger systems perspective, the practices are not as valuable and may actually be a net detriment.

Local jurisdictions and other landowners may choose to or need to install erosion control practices for their erosion protection value, independent of any nutrient or sediment credit to be earned. This dissenting document does not address when such practices should be pursued or permitted, instead only focusing on whether or not those shoreline erosion control practices should be awarded TMDL credit. Qualifying conditions have been and should continue to be quantified as part of federal, state, and local permitting processes to include explicit criteria for when erosion control practices of any kind are allowed.

Process comments

This panel, as those that came before and will come afterwards, was charged with attributing numerical values to water quality services associated with various management practices. While intentionally singular in water quality focus, this process makes consideration of other issues, such as habitat or public access, difficult if not impossible. From an integrated ecosystem perspective, this is not a sustainable approach to "valuing" management practices.

Literature Cited

Bilkovic, D.M. and M. M. Roggero. 2008. Effects of coastal development on nearshore estuarine nekton communities. Marine Ecology Progress Series 358: 27–39.

Bilkovic, D.M., M. Roggero, C.H. Hershner, K. Havens. 2006. Influence of land use on macrobenthic communities in nearshore estuarine habitats. Estuaries and Coasts 29(6B): 1185–1195.

Chesapeake Bay Program, 2006, Best Management Practices for Sediment Control and Water Clarity Enhancement, CBP/TRS-282-06; 65 p. http://www.chesapeakebay.net/content/publications/cbp_13369.pdf

Chesapeake Bay Program, 2005, Sediment in the Chesapeake Bay and Management Issues: Tidal Erosion Processes. CBP-TRS276-05, 16 p. http://www.chesapeakebay.net/content/publications/cbp_13349.pdf

Davis, JLD, R Schnabel, and R Takacs. 2008. Evaluating ecological impacts of living shorelines and shoreline habitat elements: An example from the upper western Chesapeake Bay. In S. Erdle, JLD Davis, and KG Sellner (eds.). Management, Policy, Science and Engineering of Nonstructural Erosion Control in the Chesapeake Bay: Proceedings of the 2006 Living Shoreline Summit, CRC Publ. No. 08-164.

Jennings MJ, Bozek MA, Hatzenbeler GR, Emmons EE, Staggs MD.1999. Cumulative effects of incremental shoreline habitat modification on fish assemblages in north temperate lakes. N Am J Fish Manag 19:18–27

Kirwan, ML and JP Megonigal. 2013. Tidal wetland stability in the face of human impacts and sea-level rise. Nature 504: 53-60.

Long, CW, JN Grow, JE Majoris, AH Hines. 2011. Effects of anthropogenic shoreline hardening and invasion by Phragmites australis on habitat quality for juvenile blue crabs (Callinectes sapidus). J. Exp. Mar. Biol. Ecol. 409: 215–222.

Patrick, CJ, DE Weller, X Li, M Ryder. *In press*. Effects of shoreline alteration and other stressors on submerged aquatic vegetation in subestuaries of Chesapeake Bay and the midAtlantic Coastal Bays. Estuaries and Coasts.

Palinkas, C.M., E.W. Koch, 2012. Sediment accumulation rates and submersed aquatic vegetation (SAV) distributions in the mesohaline Chesapeake Bay, USA. Estuaries and Coasts 35: 1416-1431

Peterson, M.S., Comyns, B.H., Hendon, J.R., Bond, P.J., Duff, G.A., 2000. Habitat use by early life-history stages of fishes and crustaceans along a changing estuarine landscape: differences between natural and altered shoreline sites. Wetlands Ecol. Manage. 8, 209–219.

Weis, J.S., Weis, P., Proctor, T., 1998. The extent of benthic impacts of CCA-treated wood structures in Atlantic coast estuaries. Arch. Environ. Contam. Toxicol. 34, 313–322.

Appendix M. Response to comments

Comments from USWG REVIEW

Specific comments from MDE

NORMAND GOULET (CHAIR), URBAN STORMWATER WORKGROUP; TOM SCHUELER (COORDINATOR), CHESAPEAKE STORMWATER NETWORK

FROM: *MARYLAND DEPARTMENT OF ENVIRONMENT SCIENCE SERVICES ADMINISTRATION*

SUBJECT: *QUESTIONS/COMMENTS REGARDING THE RECOMMENDATIONS OF THE EXPERT PANEL TO DEFINE REMOVAL RATES FOR SHORELINE MANAGEMENT PROJECTS*

DATE: *APRIL 11, 2014*

CC: *RAYMOND BAHR, MDE*

The Shoreline Management Expert Panel Responses are included in this memorandum to address each question/comment. Version: 4/17/14 (draft, by Sadie Drescher, Panel Coordinator)

MDE's Services applaud the Panel on their work regarding defining the removal rates for Shoreline Management Projects. We look forward to hearing the Panel's representative present their recommendations on the protocol for estimating the pollutant reduction achieved through shoreline management.

After thorough review of the document and the Appendices, MDE SSA has comments and questions reading the expert panels report which are below.

Questions/Comments on Shoreline Management Panel Report

- **Shoreline Erosion is an issue for all sectors not just Urban. Therefore this Panel Report should also be reviewed by the Agricultural Workgroup and the Forestry Workgroup.**
- **Response: This BMP is currently available in CAST, MAST, VAST for urban, forestry, and agriculture. The BMP is currently named as Shoreline Erosion Control. The shoreline management BMP pollutant load reductions are based on preventing tidal shore erosion and the pollutants removed when vegetation is part of the practice. The Agriculture Workgroup and Forestry Workgroup Coordinators and Chairs were provided with the report.**

- **Executive Summary (and other sections) - The report talks about a pollutant load reduction cap per state basin (not exceed one-third of the pollutant load to the state basin). It is uncertain where and what these numbers are and should be provided in the report. They should not be from the Watershed Model land-river segments which are landuse loads. These caps should based on the amount that the Estuary Model has for erosion from the shorelines.**

- **Response: This is a model consideration that will be discussed in more detail at the Watershed Technical Workgroup meeting on June 5, 2014. The WTWG recommends that sediment reductions from all shoreline management practices within a land-river segment should not exceed the total fine sediment shoreline erosion load estimated to enter adjacent WQSTM tidal water cells. See Appendix C for more info.**

- **Section 3.4: "Table 5 - Removal rates for shoreline erosion control (management) practices." lists shoreline erosion control removal rates at 0.02 lbs-TN/LF/yr, 0.0025 lbs-TP/LF/yr and 2 lbs-TSS/LF/yr. According to the MAST update history for July 15, 2013 (http://www.mastonline.org/UpdateHistory.aspx), the rates in the CBP models are 0.2 lbs-TN/LF/yr, 0.068 lbs-TP/LF/yr and 54.25 lbs-TSS/LF/yr. Please clarify which removal rates are currently being used in the model.**
- **Response: The July 15, 2013 MAST update history pollutant load reduction rates of 0.2 lbs-TN/LF/yr, 0.068 lbs-TP/LF/yr and 54.25 lbs-TSS/LF/yr are currently being used in the model.**
  Table 5 was updated as follows. In addition, the July 15, 2013 values were added to Table 6, "Pollutant load reductions for shoreline management practices." See red text here:

Table 19. Removal rates for shoreline erosion control (management) practices.

Source	TN (lbs per foot per year)	TP (lbs per foot per year)	TSS (lbs per foot per year)
CBPO-Approved Rate in 2003	0.02	0.0025	2
Interim Rate, 2013	0.2	0.068	54.25
Interim Rate, 2013 is found in the model tool's update history, e.g., MAST update history is online at http://www.mastonline.org/UpdateHistory.aspx (July 15, 2013). See also, Scenario Builder documentation (CBP, 2012) available online at http://www.chesapeakebay.net/documents/SB_Documentation_V24_11_01_2012.pdf			

Note that the interim rate has since been revised in the final expert panel report by the WTWG.

Section 4.2: The report has made statements regarding the applicability to Local TMDLs, meeting mitigation, or when/what the credits generated or can be used for. It is not with the Panel's charge to make these Policy statements. The paragraph should be removed. Response: Paragraph was deleted. See the marked out red text in Section 4.2:

4.2 Basic Qualifying Conditions for Individual Projects

The basic qualifying conditions that are outlined in Table 7 are the criteria a shoreline management project must meet in order to receive Chesapeake Bay TMDL pollutant load reduction. Projects that do not meet these basic qualifying conditions (e.g., a bulkhead or seawall where a living shoreline is feasible) do not receive Chesapeake Bay TMDL pollutant load reduction. Finally, no Chesapeake Bay

TMDL pollutant load reductions should be provided for projects that impact Chesapeake Bay Preservation Act protected vegetation without mitigation.

~~*For local sediment and nutrient TMDLs, shoreline management practice credits will not count toward meeting the TMDL reduction requirements unless the local TMDL is for tidal waters. While upstream reductions are necessary to meet downstream load reductions, downstream reductions will have no impact on upstream loads. Similarly shoreline management practice installation to meet mitigation requirements do not count toward meeting TMDL load reductions since these projects are designed to offset impacts and corresponding load increases elsewhere. Credits generated by shoreline management practices may not be used for both TMDL reduction credits and for nutrient and or sediment trading credit programs, such as, the Maryland Accounting for Growth nutrient trading program.*~~

- **Section 5.2.1: Step 1. The report provides a method to estimate shoreline erosion based on either the MD DNR tool or using VIMS information. If the reduction caps are based on information from the CBP models (which should be from the Estuary Model) then why should the estimate of shoreline sediment erosion rate/loss come from a totally different model?**
- **Response: See 2a above and Appendix C Technical Requirements for Entering the Shoreline Management Practice into Scenario Builder.**

- **Section 6.1: In Maryland, localities do not report to the State using any of the CBP scenario development tools (CAST, MAST, VAST). Maryland does not use CAST/MAST/VAST to report any BMPs to CBP. It states in 6.1.1 that the local government should report based on the states operating procedures. This part of the paragraph in section 6.1 should be removed. Maryland uses existing conduits/tools to acquire information regarding BMPs. This information is then provided to CBP using NEIEN.**
- **Response: Changed Section 6.1.1 Units for Local Government to Report to State as follows: The local governments should report shoreline management projects to the state based on the state's standard ~~operating procedures~~ to reporting practices. The reporting parameters are provided in Table 17.**

- **Section 6.1.1: Table 17 The table lists "8 digit watershed where project is located and/or county". Maryland has MD 8-digit watersheds but other states may not, and it also may be a requirement for the state to have the information but it may not be necessary to list this out in the table. It is important to note that NEIEN accepts federal HUCs, but no other types of watersheds/designations that a state may use. If coordinates (preferably Decimal Degrees) of the project are available they should also be reported but state reporting requirements may differ. This could be the middle of the project.**

- **Response: Good points. The EPA CBPO Nonpoint Source Data Analyst, reported that USGS HUCs and/or the latitude and longitude at the center of the project are acceptable. Table 17 was edited as follows: Table 20. Units for local governments to report to state.**

Protocol	Parameters to Report	Notes
All Protocols	• Practice type • Year installed • Location coordinates • USGS HUC and/or latitude and longitude at the project center to identify ~~8 digit watershed~~ where project is located ~~and/or county~~ • Land use(s) • If applicable, acres treated by practice	• All reporting should be coordinated with the local and state permitting and reporting authority to ensure compliance • General reporting requirements for all projects should be followed • If values other than default values are used, these calculations should be reported to the reporting entities specification (e.g., TN, TP, and TSS for sites with site specific sampling data) Records should be kept and available for inspection to relay the data source, calculations made, and other data reported to the state

- **Appendix B. 16. Cumulative or annual practice: The report says annual but in the modeling world the load reduction portion is a cumulative practice in that the restored feet or load reduction is carried over year per year because unless the project fails, the load that is reduced and continues to be reduced for the time period of the model until it becomes part of calibration.**
- **Response: This is an annual practice.**

Other issues

- **Comment: PDF page 15 has a header that is not really a header but the beginning of a sentence.**
- **Response: Do not see the header text on page 15.**

- **Comment: There are several blank areas in the document (pdf pg 34 Section 4.2).**
- **Response: Blank spaces were created when word was converted to pdf.**

- **Comment: Need page numbers for all of the pages (document page 30 starts at pdf page 40)**
- **Response : Fixed.**

- **Comment: Figure 3. The legend should be re-done, it should not have 0 or 1 even though it is explained in the caption.**
- **Response: Fixed.**

Specific comments from USWG Approval Meeting

Salvati: Armored and living shorelines often seem to impact our mandated resource protection areas. Suggest adding some text that the installed practice is the minimum needed to address the erosion issue. That could help minimize any impact to the protection area.

Drescher noted some language in the report about not infringing on the resource protection areas

.

Antos: We are building capability to include other information, such as cost and ecosystem services, into the Partnership's modeling tools such as CAST/MAST/VAST. One difficulty has been obtaining quantitative ecosystem services information. Where these shoreline practices affect other ecosystem services, it could be beneficial to have data to build into our decision support tools such as CAST/MAST/VAST to help better improve planning or decision making.

Davis: This panel and the dissenting group sparked a discussion about how to engage other Goal Implementation Teams (GITs). The Habitat GIT is developing a set of recommendations to the WQGIT that will address these concerns. For example, notifying other GITs before panels are launched and if there are strong concerns for habitat or fishery reasons, then perhaps that given BMP may not move forward or the charge would be modified. There is currently no official way to engage the other GITs.

Drescher noted that there were some comments received from MDE on the report; she thanked MDE for providing the comments.

Debbie Cappacetti (MDE): The steam restoration protocol 1 does not allow credit for armoring or structure repair and requires a demonstration of an ecosystem benefit to earn credit. Wondering why this report allows some of those same armoring practices get credit in this report.

Drescher: The armoring practices would not receive CB TMDL credit unless they were previously eroding and living shorelines were not possible at the site, per the basic qualifying conditions. This would occur in a very limited number of cases.

Stack: We did not reach full consensus on this, but the majority sensed that there would be very few of these projects in urban cases.

Antos: the focus of the report seemed to be Maryland and Virginia, but could these credits also be used in tidal areas of DC or Delaware?

Drescher: Yes, we discussed that in the report and coordinated with those jurisdictions.

Sarah Lane (MD DNR): Our concern is that the damage is already done and these (armored) projects have already been permitted and some of the concerns that have been raised will not be addressed in the near term. To clarify, these hardened shorelines can apply to other land uses such as forest or agriculture?

Stack: No. The armored practices could only receive credit in ultra-urban areas like ports.

Drescher: Right, only very limited conditions as noted in Table 7.

Goulet: For example, if there is a failing bulkhead in a recreational marina, could a replacement bulkhead receive credit?

Davis: The logic would be that you only get credit if is previously eroding. So you could not get credit for replacing a bulkhead with another bulkhead.

Sarah Lane: Question about Table 7 (page 25, Attachment C). Revetment and breakwater systems are still technical hardened areas. Did the panel discuss how these practices would maybe create more hardened areas where we may not want them?

Drescher: We added the language about SAV just to reinforce that point.

Davis: From a habitat perspective the best thing is not to do anything with the shoreline. The reason for installing these armored practices should be infrastructure protection. If the landowner needs to protect their infrastructure from erosion, then they should use a living shoreline. Our concern is
these practices will be installed for water quality credit in the Model. Living and armored shorelines have negative impacts from the habitat perspective.

Sarah Lane: Perhaps the infrastructure protection could be a qualifying condition.

Goulet: Like the suggested approach and defining the qualifying conditions a little more clearly. Get the sense that the there probably will not be consensus regardless of the qualifying conditions. The dissenting group appears to have some fundamental differences of opinion about the management and consequences of these practices.

Davis: That seems fair to say.

Jeff Halka (MD Geologic Survey): It really is a philosophical issue. Some dissenters felt we could never have enough qualifying conditions to make it acceptable. Shore erosion is a natural process. It is difficult to arrive at a resolution from the management perspective.

Steve Stewart (Baltimore County): From that perspective, stream erosion is also a natural process, but we have modified that process and made it worse through our own actions.

Salvati agreed with Stewart and reiterated the suggestion to minimize.

Salvati: From my perspective this raises a very important policy question.

Goulet: There is a lot of great discussion and important points being made. The role of the USWG is to weigh in on the technical aspects of the panel's recommendations and we should focus on that. The larger policy or philosophical questions are the purview of the WQGIT, with the other GITs weighing in from their perspective. The philosophical issues are important, but propose that those are questions that need to be raised and answered at the WQGIT, or maybe even the Management Board if necessary to resolve cross-GIT issues. Are there questions with respect to technical nature of the BMP?

Davis-Martin: back to table 7 row 2. Revetment and breakwater systems. Is there any credit for a revetment system alone?

Drescher: It means a revetment and/or breakwater system, so it could be one or both. Will edit the text to clarify this.

Goulet: Not hearing any technical objections to the BMP report that would prevent it from moving forward.

Sarah Lane: Based on MD DNR's discussions we are unable to support protocol 1, but support the other protocols. Feel that the qualifying conditions are a part of the charge.

Schueler: If it moves forward we should clearly define the two options for decision by the WTWG or WQGIT: the report as written and the report as proposed by the dissenting members. Clearly this is a larger philosophical question that the WQGIT should consider.

Salvati: is there a mechanism for flagging these issues as the report goes through the other workgroups?

Schueler: The policy issues are not the prerogative for the workgroup, but fall to the states to handle the policy aspects or decisions. Want to compliment Drescher, the panel, and the dissenters for being so thorough and compiling such an excellent report. Feel that from the USWG perspective the panel has met the charge and has laid out the options for the WQGIT.

Goulet: With that, recommend submitting the report to the WTWG. He called for any further objections or comments; none were raised.

Comments from the WTWG review process

From: Keeling, William (DEQ) [mailto:william.keeling@deq.virginia.gov]
Sent: Friday, November 07, 2014 9:15 AM
To: Lewis Linker; Bill Stack
Cc: Matt Johnston; Neely Law; Reid Christianson; Cerco, Carl F ERDC-RDE-EL-MS; Gary Shenk; Ping Wang
Subject: RE: Shoreline Nutrient Load Cap

Lew and Bill,

I am having a little trouble with a basin scale cap and will try and explain. We have multiple jurisdictions here in VA that are not at all happy with the basin they have been included with such as the Lynnhaven (VA Beach) which discharges directly into CB8PH and not the James yet they are assigned to the James basin. I am sure Dr. Cerco might be able to tell us what influence the Lynnhaven has on the James verses CB8PH and vise versa and similar to other localities or segmentsheds that are assigned to a basin but may or may not influence that basins loadings. We also have allocations in the TMDLs at the segmentshed scale and am wondering if we tied the cap to the allocated loadings in the TMDLs or segmentshed loads we could avoid potential conflicts between assigned areas to basins that have little impact on those basin loadings? I am also wondering if we apply condition 1 caps do we really need caps at a larger scale? I am having trouble understanding how a specific installation at a specified location within a segmentshed or basin could produce loading reductions greater than the overall basin loads. Does that mean these protocols calculated sediment reductions are so large that a few installations of them could produce the basins overall loading reductions and therefore need capping at that scale? Or are we assuming if the entire available or erodible shoreline is treated capping that amount at a percentage of the total basin load?

I thought we were looking at basically the condition 1 cap of looking at the adjacent WQSTM model cell(s) available loadings and capping it to some percentage of that available load if the reported BMP reductions were going to eliminate most if not all or exceed that available loading. If a cap is instituted at that scale it would seem that capping things at the larger scale of segmentshed or basin would not be needed. Regards,

Bill

William Keeling
Virginia Department of Environmental Quality
629 E. Main Street
Richmond VA, 23219 804-698-4342
william.keeling@deq.virginia.gov

Email chain with RESPONSE

Agree with Lew's edits in red below.

William Keeling
Virginia Department of Environmental Quality
629 E. Main Street
Richmond VA, 23219 804-698-4342

william.keeling@deq.virginia.gov

From: Lewis Linker [mailto:LLinker@chesapeakebay.net]
Sent: Friday, November 14, 2014 3:55 PM **To:**
Matt Johnston; Bill Stack
Cc: Neely Law; Keeling, William (DEQ)
Subject: RE: Shoreline Nutrient Load Cap

Hi Matt & Bill:

Looks good with changes below in **Red Bold.**

- Lew

From: Matt Johnston
Sent: Thursday, November 13, 2014 11:11 AM
To: Bill Stack
Cc: Neely Law; Lewis Linker; Keeling, William (DEQ) (william.keeling@deq.virginia.gov)
Subject: RE: Shoreline Nutrient Load Cap

Bill,

I can make those changes to the appendix. I want to make sure I reflect these appropriately. Is the following correct?

a. Protocol 1 will be approved for TSS only at this time pending an evaluation of the availability/reactivity of TP **and TN** associated with shoreline sediments and the impact that nutrient crediting might have on TMDL accounting at the **land-river** segment.
    i. After this evaluation, the WTWG may be asked to approve a revised nutrient reduction credit for this practice.
    ii. We will modify the cap for the ~~maximum~~ amount of TSS that can be credited for Protocol 1 so that it is ~~more~~ **credible and** scientifically defensible. Language: "The WTWG recommends that sediment reductions from all shoreline management practices within a land-river segment should not exceed the total fine sediment shoreline erosion load estimated to enter adjacent WQSTM tidal water cells. Note that one land-river segment can be adjacent to multiple tidal water cells."
b. Protocols 2, 3 and 4 will be approved for TN, TP and TSS.

Matthew E. Johnston
Chesapeake Bay Program Nonpoint Source Data Analyst
University of Maryland
Department of Environmental Science and Technology
410-267-5707

Comments from the WQGIT Review Process

Comments from Chris Spaur, USACE

Suggested Revisions to "Recommendations of the Expert Panel to Define Removal Rates for Shoreline Management Projects," version date 12/4/14. Provided by Chris Spaur, USACE Baltimore District

Page, Paragraph	Section	Suggested Revision	Rationale
P. 1 (or p. 6 as per below)	Executive Summary	Insert sentences as new paragraph 2: Bay shorelines have been erosional over the entire geological history of the Bay. Eroding shorelines are fundamental to the environmental character of Chesapeake Bay and serve to simultaneously create, maintain, and destroy a variety of shoreline and nearshore habitats. A basic challenge of shoreline management is how to balance maintaining natural shoreline processes and habitats — fundamental to the character and health of the Chesapeake Bay — with the legal right of shoreline property owners to protect their properties from erosion. About one-seventh of the Bay's shorelines are now stabilized (USACE, 2011).	To provide context otherwise not included in executive summary.

P.4	Executive Summary	Insert sentences informing the reader of Appendix L (Dissenting View Document) and summarizing those opinions. These could be as new paragraph.	The executive summary fails to mention that 40% of the panel disagreed with providing TMDL credits for shoreline stabilization that includes structures as is covered in Protocol 1. The executive summary is the most widely read part of documents, relatively few people wade into document innards. Thus, explicit mention of this situation (internal panel disagreement) needs to be mentioned in executive summary.
P.4	Executive Summary	Insert sentences informing the reader that comments on report were received expressing concern/disagreement over giving TMDL credits for shoreline stabilization that includes structures.	Document that comments were received.
P. 6 (or p. 1 as per above)	6.2	Insert sentences as new paragraph: Bay shorelines have been erosional over the entire geological history of the Bay. Eroding shorelines are fundamental to the environmental character of	To provide additional context otherwise not included in report.

		Chesapeake Bay and serve to simultaneously create, maintain, and destroy a variety of shoreline and nearshore habitats. A basic challenge of shoreline management is how to balance maintaining natural shoreline processes and habitats — fundamental to the character and health of the Chesapeake Bay — with the legal right of shoreline property owners to protect their properties from erosion. About one-seventh of the Bay's shorelines are now stabilized (USACE, 2011).	

US Army Corps of Engineers. 2011. Chesapeake Bay Shoreline Erosion in Maryland: A Management Guide. Baltimore, MD: U.S. Army Corps of Engineers, Baltimore District.
Note at Jenn Volk's request, Chris's comments were inserted into the report as they were mainly clarifying and didn't change the substance of the Panel recommendations.

Lucinda, Jenn and Bill,

Thanks for including an action item to follow up with me. I see that you mention "Chris Bauer" as part of the action item. I believe Chris's last name is "Spaur", not "Bauer". Also, I wanted to update you on a key aspect of the concerns I expressed in my earlier email.

When I wrote my email to WQGIT last week I was mistaken regarding one of the report's key recommendations. I initially thought the WTWG at this stage was explicitly recommending that nutrient credits be given for shoreline protection in association with erosion prevention. Now I see that at this point the WTWG is NOT recommending that nutrient credits be given in association with prevented sediment.

I am relieved that nutrient credits are not being proposed in association with prevented sediment. NOT including nutrient credits for prevented sediment greatly reduces the incentive to use shoreline protection as an alternative to other proven nutrient prevention approaches such as storm water management and, thus, reduces the urgency of my concern.

My understanding is that the nutrients contained in most shoreline sediment are likely to be not nearly as available/reactive as those contained in other parts of the watershed. Thus I strongly agree with the WTWG's conclusion that, without additional information, it would be premature at this point to provide a nutrient credit as part of Protocol 1.

I still feel that shoreline erosion is often a natural process with important geological and ecological functions, and I still agree with all the arguments of the "dissenting group". But, as long as nutrient credits at this point are not allowed for prevented sediment, I do not feel a need to further interrupt the deliberations of WQGIT before their vote on February 9th.

I'm still not convinced that even a credit for prevented fine sediment is sensible, but that is a bigger issue related to the entire Bay Program's TMDL process for sediments.

Sincerely,

Carl T. Friedrichs
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From: Jennifer Tribo [mailto:jtribo@hrpdcva.gov]
Sent: Wednesday, February 25, 2015 3:56 PM
To: Wood, DavidM
Subject: RE: Shoreline Management Report

David - I apologize for the delay in commenting on this topic, but I was going over all the information again after Monday's WQGIT call. I noticed a discrepancy in the average delivery for fine grained sediments for Maryland. In Bill Stack's presentation the rate is 1.34 kg/m/day, but the rate in the tables from the 2010 document you sent out earlier and the Halka presentation and poster all have the rate at 1.25-1.26. Where did the 1.34 come from and which number was used to compute the proposed default rate?

Thanks. Jenny
RESPONSE

Jennifer Tribo jtribo@hrpdcva.gov

Bill - Thanks for the quick follow-up on this issue.

Jenny

From: Bill Stack [bps@cwp.org]
Sent: Thursday, February 26, 2015 11:44 AM
To: Wood, DavidM; Jennifer Tribo
Cc: Lewis Linker; Neely Law; Sadie Drescher; Matt Johnston; Julie Winters (winters.julie@epa.gov)
Subject: FW: Tidal Shoreline Management Report

Hi Jenny and David,
Please see Jeff Halka's explanation of the differences in the fine sediment loading rates. Note all references to Cerco 2010) in the Expert Panel Report will be changed to (Halka, 2013) as appropriate.
Let me know if you have any questions.
Bill
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From: Jeff Halka -DNR- [mailto:jeff.halka@maryland.gov]
Sent: Thursday, February 26, 2015 11:16 AM
To: Bill Stack
Subject: Re: Tidal Shoreline Management Report

Sorry for the delay Bill:
So......Looking back at the various files in my records this is what I think happened.
After the final presentation that Cerco cites in his report (given in July of 06) we clearly made an update to the data for MD, because I have an October file date on the powerpoint presentation that Cerco cited (not the July presentation date). The associated files (excel spreadsheets) located in that folder are also all dated October 06, and have the numbers that I gave to the panel. I think that Cerco should have gotten the updated numbers, but I don't actually know because the colleague at the Bay Program would/should have forwarded the information, and I have no record of that. Carl may or may not have had the time at that point to change the modeling numbers.
I wouldn't characterize the difference as "slight difference"....it is actually ~13%. Interestingly, the % change is the same for both the fines and the coarse fractions. This makes me think that there was some change in the bulk density calculation for the eroding shorelines. Organics only changed by <2%, but a different density factor was used for marsh soils which were the only ones for which an organic component was utilized.
So the numbers that I gave the panel are the correct ones to use, but obviously they are different from Cerco and hence from what is used in the Bay Model. Not sure how much of an issue that might be for the Technical Workgroup. I believe that in the end the model is "adjusted" in a manner that allows the input components to result in a match to observed WQ data. I recollect that Carl stated in a presentation that the shore erosion inputs were so large for some segments that they had to be scaled back for the light attenuation portion of the model to work. But I can find no direct statement to that effect in his report (but I haven't combed through it completely).

So that is it, as far as I can tell. It disturbs me that the numbers don't match, but "it is what it is" Let me know if you need any more help with this, or if you think that digging further into the verbiage of the Cerco report might help with the Technical WG and Watershed Implementation team. Thanks, Jeff

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From: Bill Stack [mailto:bps@cwp.org]
Sent: Friday, January 30, 2015 4:39 PM
To: McNally, Dianne
Subject: Default Rate for Tidal Shoreline Practices
Hi Dianne,
In response to our abbreviated discussion regarding the use of the default value for stream restoration default for tidal shoreline practices, I consulted with Lew Linker and Matt Johnson who were involved in developing the land-river segment cap when the issue was raised by VA DEQ by the WTWG meeting. I have attached a revised default rate which is based on average fine sediment shoreline erosion rates that is more scientifically defensible than using the stream default rates and better aligns the default rate with the estimated loadings from the Water Quality Sediment Transport Model estimates for landriver segments. The WTWG will be discussing this modification next week.

I look forward to our discussion next week.

Bill

Sent: Friday, February 20, 2015 9:37 AM
To: 'McNally, Dianne'
Cc: Linker, Lewis; Matt Johnston; Spagnolo, Ralph; Martinsen, Jessica; 'Neely Law' (nll@cwp.org); Power, Lucinda
Subject: RE: Default Rate for Tidal Shoreline Practices
Dianne,
My responses are italicized below. I look forward to our discussion on Monday.
Bill
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From: McNally, Dianne [mailto:mcnally.dianne@epa.gov]
Sent: Wednesday, February 18, 2015 1:29 PM
To: Bill Stack
Cc: Linker, Lewis; Matt Johnston; Spagnolo, Ralph; Martinsen, Jessica **Subject:**
RE: Default Rate for Tidal Shoreline Practices

Bill, do you have some time tomorrow afternoon to answer a few more questions on this report? I'm sending you this list of questions for us to discuss. I just want to make sure I'm understanding everything from our last call—

1. Decision was made to not have a qualifying condition of an erosion rate <2ft/yr to promote SAV (p. 25), indicating that more research was needed (Section 7). I didn't see the referenced in Section 7. Is the plan to allow this sometime in the future? What are the next steps, if any?

Response: The recommendation was included in Table 18. "There is a need to research and identify SAV habitat where future growth can be supported, report shoreline erosion control structure impacts to SAV, and develop policy recommendations based on these findings. Also, habitat research, the associated basic qualifying conditions, and the resulting policy recommendations are needed. This research can inform the Chesapeake Bay TMDL pollutant load reduction basic qualifying condition criteria that promote SAV and other nearshore habitat.

Note: A large body of research examining the impact of shoreline types, including shoreline erosion control structures, on SAV and other habitats and species will be available for the next expert panel's consideration (i.e., in two years). I will modify this language so that it relates more specifically to the language on page 25. Further, there is no formal process for following up on the recommendations from the Expert Panel Reports that I am aware of. My understanding is that the recommendations are for the CBP staff and different committees that review the panel reports to act on as they see fit. For instance the WQGIT could recommend that this research need be followed up on by CBP staff or their subcontractors. Perhaps Lucinda can address if there is a more formal process for following up on these recommendations.

2. Could you please help me to understand again how the panel addressed the dissenting opinion on removing Protocol 1 for sediment? I realized that you addressed their N and P concerns by deferring until later. Lew mentioned that 80-90% of the shoreline is private land. I think I understood him to say that because of that, counties wouldn't have the ability to do blanket shoreline management practices to get credit in the model—they would be relying on private homeowners to do the work. On N and P, if we defer until later, will their issues be addressed?

Response: The dissenting opinion was included in the report for consideration by Urban Stormwater Work Group, Watershed Technical Work Group and Water Quality GIT. The concern raised by the dissenting opinion in part was responsible for eliminating credits for nutrients. It is likely (especially if requested by the WQGIT) that the same or another Expert Panel will be formed to specifically formed to address this issue although the timing is uncertain. The issues raised by the Dissenting Opinion should be one of the most important considerations by the panel as well as the technical considerations raised by the Watershed Technical Work Group.

3. Section 6.2 paragraphs 1 and 2 appear to be saying exactly the same thing. Am I missing something here? At the end of paragraph 1 of this section, it states that credit won't be provided where SAV is already present. It also states that the jurisdiction or EPA may chose not to provide credit where another natural resource is adversely affected. How is that determination made? Can EPA decide to not credit something that the jurisdiction has submitted?

Response: The second paragraph will be edited to eliminate the redundant language. The following language was recommended by the expert Panel as one of the most important qualifying conditions for issuing credits. "Therefore, to avoid encouragement of adverse impacts on SAV, credit ~~is not~~ should not be provided for erosion control practices in areas in which SAV is already present. Jurisdiction and, or EPA may choose to not provide credit when another natural resources are adversely affected by the use shoreline management practices." I believe this language should be modified slightly as indicated in red. Qualifying conditions included in Expert Panel Reports are *recommendations to the CBP and state agencies representatives. Including a process for how these recommendations will be implemented would be overly prescriptive as the state agencies should have the best understanding of how they can be effectively implemented.*

I appreciate you taking the time to help me to understand these issues prior to the call on Monday. If Thursday isn't good, perhaps we can chat first thing on Monday.

Thanks.
Dianne
Dianne J. McNally
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Comments from Lee Curry, MDE. February 20, 2015

Bill, Thanks for your time today. Below is what I sent to DNR for their input.

Bill and I talked about the report and proposed the following additions. I think this satisfies the concerns we raised, but please let me know if I missed something. The intent of the below additions are to address the concern regarding sediment credits that have negative impacts to other natural resources.

Add footnote to Table 1. Summary of shoreline management pollutant load reduction for individual projects. The footnote would read.

In protocol 1 credit is not provided for erosion control practices in areas in which SAV is already present. In addition, Jurisdiction and, or EPA may choose to not provide credit when other natural resources are adversely affected by the use shoreline management practices.

Add to section 2.1.2 - add recommendation to update scenario builder definitions to include

credit is not provided for erosion control practices in areas in which SAV is already present. In addition, Jurisdiction and, or EPA may choose to not provide credit when other natural resources are adversely affected by the use shoreline management practices.

Add to 2.1.3 Expert Panel Definition credit is not provided for erosion control practices in areas in which SAV is already present. In addition, Jurisdiction and, or EPA may choose to not provide credit when other natural resources are adversely affected by the use shoreline management practices or conflict with .

Add step to Section 5.2.1 Should begin with a step 1, which is to determine if the site is eligible for sediment credit.

Credit is not provided for erosion control practices in areas in which SAV is already present. In addition, Jurisdiction and, or EPA may choose to not provide credit when other natural resources are adversely affected by the use shoreline management practices or conflict with .

____

On Fri, Feb 20, 2015 at 11:29 AM, Bill Stack <bps@cwp.org> wrote:

Hi Lee,

Under the "Unintended Consequences" Section (6.2) of the Panel Report the following language tries to address your major concern associated with Protocol 1. *The shoreline zone of the Chesapeake is host to many different habitat types such as emergent wetland, SAV, oyster reef, coarse woody debris, mudflat, etc., many of which themselves are known to host higher macrofaunal species densities and diversities than armored shoreline erosion control devices. Two of these habitats, oyster and SAV both, are currently managed by the Chesapeake Bay Program Office with the goal to achieve higher levels of distribution. Additionally, specific minimum SAV acreage requirements have been established to remove a water body from the 303d list of impairments for water clarity. Installation of erosion control devices can be at the expense of these other habitat types. As an example, studies show that reduction in erosion in some cases can negatively impact SAV, and that SAV densities are highest in areas of mid-range erosion rates (Palinkas and Koch, 2012). Therefore, to avoid encouragement of adverse impacts on SAV, credit is not provided for erosion control practices in areas in which SAV is already present. Jurisdiction and, or EPA may choose to not provide credit when another natural resources are adversely affected by the use shoreline management practices.*

Do you have any suggested changes to this language? Wouldn't also the qualifying conditions in Table 7 also address the concern about limiting armoring to port facilities etc?

I look forward to our discussion at 3:30

William P. Stack, P.E.

____ On

Thu, Mar 5, 2015 at 9:20 AM, Bill Stack <bps@cwp.org> wrote:

Hi Lee,

I am not sure if Lee Karrh talked to you about his suggested changes but I think they add greater guidance to the panel report. I will be talking to James Davis Martin tomorrow and as you know his suggestions about eliminating the sand reduction factor and allowing each state to decide on how to credit bulkheads under Protocol 1 are in complete disagreement with the recommendations of the Expert Panel Report and the concerns raised by Lee Karrh. His argument about eliminating the sand reduction factor doesn't make sense because we would be disproportionally giving more credit for tidal shoreline practices than watershed BMPs, because of the substantially greater percentage of sand in those soils than the watershed. His argument to allow the use of bulk heads everywhere is contrary to Habitat GIT SAV goals as Lee mentioned.

If I am not successful in convincing James, I might need your support at the GIT meeting. Postponing a decision for further study will essentially mean that no protocols will be approved as we do not have any budget in our CBP work Plan to continue work on this.

Thanks,
Bill

William P. Stack, P.E.

D. Lee Currey, P.E.
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Hi James,
Thanks for your input. I agree that discounting the effectiveness of a BMP based on sand content is a slippery slope (depending on the sand content ☺) . The Panel made recommendations on how to minimize unintended consequences with suggested "work-arounds" with the understanding that these suggestions would be conveyed to the USWG, WTWG and the WQGIT for their ultimate approval. I just looked at Section 9. SEDIMENT SIMULATION from the Chesapeake Bay Phase 5.3 Community Watershed Model documentation to get a better understanding of how sand is accounted for in the watershed model and what effect a sand content has on the effectiveness of upland BMPs. According to the model documentation, the average sand content from the watershed is assumed to be 15% which is much smaller than the content from tidal shoreline sediments. Also, a sediment delivery factor is applied to these loadings which discounts the sand factor appreciably. I know from recent experience with the Stream Expert Panel Report the sediment delivery factor for stream restoration projects is quite large (6.1% for stream restoration projects in the coastal plain). Therefore, my understanding is that the effectiveness of urban BMPs is discounted for sand through the transport process. Since I am not a modeler I have asked Lew if he would look into this further.

Also, regarding your question, *"While I agree in concept with the upland bank stability reduction factor, I am not sure about the 50% value. "The only study referenced in the report is from Calvert Cliffs…hardly*

typical of Bay tidal shorelines. I looked back through the panel minutes and did not see any discussion of the value." , the 50% stability reduction factor was a conservative assumption that the Expert Panel decided that was not based on any studies. I would appreciate any suggestions for alternatives. I look forward to our discussion on Monday.
Bill
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From: Davis-Martin, James (DEQ) [mailto:James.Davis-Martin@deq.virginia.gov]
Sent: Thursday, February 19, 2015 5:40 PM
To: Bill Stack
Cc: Jennifer Volk; Lucinda Power; Wood, DavidM **Subject:**
Shoreline Management BMP Panel Report

Bill:

Just to let you know, in advance of the GIT call on Monday, I am not supportive of the Panel Report as written. My concerns are as follows:

From the BMP Protocol:

"The scope of the BMP Expert Panels is to develop definitions and loading or effectiveness estimates for nutrient- and sediment-reducing technologies and practices. However, Panel members will be expected to identify any ancillary benefits or unintended consequences beyond impacts on nitrogen, phosphorus and sediment loads."

This panel is going beyond the scope and is proposing to discount the N, P, and S effectiveness estimates based on potential unintended consequences. Even if I were convinced by the report of the adverse effects, I would not support using this model-driven process as the mechanism to address it.

The panels proposal to discount TSS benefits to only credit fine particles is a slippery slope. If the concept is approved here, the next logical step would be the re-evaluation of all of our other BMPs to consider similar TSS fractioning. That would be really bad news for the Urban sector! Would the TMDL even be attainable if we did so?

Like all other BMPs, we must rely on the expertise of the implementers to use the right practice for the site. I suspect there are many sites where the <u>best</u> management practice given the specific site conditions is a hardened shoreline structure. That BMP reduces loads and improves water quality, and should get full credit for such in the models. These BMPs require permits. If the proposed structure is not an appropriate BMP for a site the permit should not be issued.

I look forward to the discussion on Monday and am interested to hear other perspectives on the report.

James Davis-Martin
Chesapeake Bay Coordinator
Virginia Department of Environmental Quality (804)
698-4298

From: Davis-Martin, James (DEQ) [mailto:James.Davis-Martin@deq.virginia.gov]
Sent: Tuesday, March 03, 2015 2:00 PM
To: Bill Stack
Cc: Lucinda Power; Jennifer Volk; McNally, Dianne; egiese@chesapeakebay.net ; Wood, DavidM; Lee Currey -MDE-
Subject: Comments on Shoreline Management Report

Here are my comments on the Shoreline Management Report. My specific suggestions for changes are in **bold**, the rest is justification for the change.

1. From the BMP Protocol: "The scope of the BMP Expert Panels is to develop definitions and loading or effectiveness estimates for nutrient- and sediment-reducing technologies and practices. However, Panel members will be expected to identify any ancillary benefits or unintended consequences beyond impacts on nitrogen, phosphorus and sediment loads."

   This panel is going beyond this scope and is proposing to discount the N, P, and S effectiveness estimates based on potential unintended consequences. **The sand reduction factor should be eliminated and the discussion of beneficial impact of sand should be shifted to the unintended consequences section of the report. MD proposed language that would give Jurisdictions the option of not reporting or partially crediting BMPs if they felt the unintended consequences outweighed the benefits should be added.**

2. The report includes a qualifying condition to report practices…"The site is currently experiencing shoreline erosion. The site was graded, vegetated, and excess sediment was removed or used."

   Then the report goes on to apply a reduction to Protocol 1 prevented sediment to account for continued instability of the upland bank. "The panel recognized that tidal shoreline management projects that do not adequately address the critical angle of repose are at a continued risk of erosion due to waves and usual storm events…This means that the Protocol 1 – Prevented Sediment should be calculated and then reduced by 50% unless it is demonstrated that the project addresses the angle of repose through bank grading and stabilization.

   The shoreline management project should provide detailed bank stability analysis to the local reporting agency to document that no additional sediment and associated pollutants will enter the nearshore waters to include the following conditions: 1) the project was graded and vegetated so that the bank is stable and 2) excess sediment was removed offsite so that the sediment does not enter the nearshore waters…"

Can't have both a qualifying condition and reduction factor for the same condition**…Remove the "graded, vegetated, and excess sediment was removed or used" sentence from the qualifying conditions and keep the 50% upland stability reduction factor to discount for unstable upland banks.** The MD proposed language to allow Jurisdictions the option of not reporting or partially crediting can apply here as well.

3. The report says "shoreline erosion (nearshore and fastland) accounts for approximately 57% of the sediment source loads to the Bay." We all recognize that the Bay's tidal shorelines are highly variable. Bank heights range from less than a foot to over 100 feet. Fetches range from feet to many miles, producing enormous differences in wave energy. As a result, erosion rates vary from accreting to more than 10 feet per year. I think we can all agree that the preferred method to control shoreline erosion is with a living shorelines approach. However, I think we can also all agree that this approach is not the best management practice for every shoreline. There are cases where the use of seawalls, bulkheads, and revetments, made from a variety of materials, may be the best approach for a particular shoreline reach. According to the report, these structures are 100% effective at preventing continued fastland erosion. Anytime an eroding fastland is stabilized (even with living shoreline approaches), it can increase nearshore erosion because the supply of renourishing fastland material is cut off. Some structural stabilization methods can cause an even more pronounced nearshore erosion rate due to reflected wave energy. However, this nearshore scour would be expected to subside over time as dynamic equilibrium is reached.

The Bay models account for sediment derived from the full range of Bay tidal shorelines. This panel report must give reduction credit for practices that would be used to control erosion in the Bay's high energy areas. **Revetments, breakwaters, bulkheads and seawalls should all be eligible for Protocol 1 reductions.** The MD proposed language to allow Jurisdictions the option of not reporting or partially crediting can apply here as well.

4. The report says that nutrient removal efficiencies are withheld pending assessment by the WTWG. Given that there is no urgency for completing the approval of this report, let's **wait until the WTWG has completed its assessment so the WQGIT can approve a complete report with efficiencies for N, P and S.**

James Davis-Martin
Chesapeake Bay Coordinator
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(804) 698-4298

From: Lee Currey -MDE- [mailto:lee.currey@maryland.gov]
Sent: Wednesday, March 11, 2015 4:49 PM
To: McNally, Dianne
Cc: Jennifer Volk; Davis-Martin, James (DEQ); Bill Stack; Lucinda Power; egiese@chesapeakebay.net; Wood, DavidM
Subject: Re: Comments on Shoreline Management Report

After taking some more time to digest this, I have the following thoughts. First, based upon the review guidance, the charge of the expert panel is to

1. Recommend nitrogen, phosphorus, and sediment loading or effectiveness estimates
2. Identify any ancillary benefits or unintended consequences beyond impacts on nitrogen, phosphorus and sediment loads.
3. Locations within the Chesapeake Bay watershed where this practice is applicable

Item 1 is strictly a technical analysis to determine the reductions. I tend to agree with James that inclusion sand factor is a policy decision.

Item 2 recognizes unintended consequences which we have not dealt with before. The WQGIT guidance does not consider how to approach this in the review and approval process.

Item 3 speaks to location, but am not sure what this means or how it should be used.

Because this is the first BMP that we have identified that has documented unintended consequences we are setting a precedent on whether or how we implement the load reductions. It is not that we disagree with the load reduction estimates; it just seems that we do not know what to do with respect to the unintended consequences. It is not clear on approval of the report vs. approval of the BMP for reductions. Some thoughts:

- Agree with previous email and would like the report to include summary table of the BMPs negative impacts to Bay Agreement outcomes (e.g. SAV)
- BMP guidance should include language that EPA or a jurisdiction may choose not to incentivize (received reduction credit) for a BMP that has negative impacts.
- Guidance could include language where a jurisdiction supports the panel report (strictly science and not policy) and a second decision that the jurisdiction votes on whether to incentivize (receive credit) for the practice.

Lee

-Email Chain --------- Forwarded message ---------- From:
McNally, Dianne <mcnally.dianne@epa.gov>
Date: Wed, Mar 11, 2015 at 11:05 AM
Subject: RE: Comments on Shoreline Management Report
To: Jennifer Volk <jennvolk@udel.edu>, "Davis-Martin, James (DEQ)" <James.Davis-Martin@deq.virginia.gov>
Cc: Bill Stack <bps@cwp.org>, Lucinda Power <lucindapower@yahoo.com>, "egiese@chesapeakebay.net" <egiese@chesapeakebay.net>, "Wood, DavidM" <Wood.DavidM@epa.gov>, Lee Currey -MDE- <lee.currey@maryland.gov>

Thanks, James. I agree that we need to figure out a way to address the unintended consequences. Your suggestion made me think of the WRR (http://watershedresourcesregistry.com/). I understand that this tool is being used in Maryland to identify sites that will result in the least environmental impact. I believe there is work underway to expand to other states. Maybe that information (or other databases) can be incorporated into CAST, as you suggest.

Also, the stream restoration BMP expert panel report does have qualifying conditions, although I don't recall if it actually factored in a reduction factor for unintended consequences.

Thanks.

Dianne 215-814-3297

From: Jennifer Volk [mailto:jennvolk@udel.edu]
Sent: Tuesday, March 10, 2015 4:00 PM
To: Davis-Martin, James (DEQ)
Cc: McNally, Dianne; Bill Stack; Lucinda Power; egiese@chesapeakebay.net; Wood, DavidM; Lee Currey MDE-
Subject: Re: Comments on Shoreline Management Report

I love this concept, James!

"I could picture including a column for each of the relevant outcomes to the BMP table that would be populated with a score ranging from -10 to 10 to represent the impact the BMP has on that outcome. Shoreline Management might score a -7 for SAV and a -4 for forest buffers but a +6 for wetlands for example. But these scores would not affect the nutrient and sediment reduction efficiencies used in the model. The information could be built into CAST to allow for the calculation of Goal and Outcome scores for implementation scenarios. The data could also potentially feed into a future optimization model for use in WIP III development."

On Thu, Mar 5, 2015 at 1:43 PM, Davis-Martin, James (DEQ) <James.Davis-Martin@deq.virginia.gov> wrote:

To the best of my knowledge, this is the first panel report that explicitly factors unintended consequences into the efficiency estimate (sand reduction factor). The others have identified the issues as concerns that should be considered when selecting the best BMP, as required in the Protocol. I would say that allowing this report to advance would bring previously approved reports into question. If sand is good and needed in the estuary, shouldn't the sand fraction be discounted for all BMPs or at least those that are implemented in the coastal areas?

In previous discussions between the WQGIT and Habitat GIT, we talked about adding some description of unintended consequences and ancillary benefits in the table with the BMP definitions and efficiencies. I think this is the best way for us to integrate multiple goals. I could picture including a column for each of the relevant outcomes to the BMP table that would be populated with a score ranging from -10 to 10 to represent the impact the BMP has on that outcome. Shoreline Management might score a -7 for SAV and a -4 for forest buffers but a +6 for wetlands for example. But these scores would not affect the nutrient and sediment reduction efficiencies used in the model. The information could be built into

CAST to allow for the calculation of Goal and Outcome scores for implementation scenarios. The data could also potentially feed into a future optimization model for use in WIP III development.

I am not as concerned about the dissenting position. I do not think there was dissention on the actual efficiency of the shoreline management practices, rather the dissention was about the unintended consequences of those practices and how factor that into the recommendations. Our BMP protocol is clear on this point and should have been the basis for the decision. In fact, the issues I have raised regarding the sand reduction factor, the 50% slope instability reduction/qualifying condition and the exclusion of structural shoreline practices were all modifications to try to satisfy dissenters whose position is in contradiction to the Protocol.

I do not think that we should set a minimum erosion rate for qualifying reductions. Site specific conditions are too variable. I could take you to sites where an erosion rate of 1 foot per year would present a huge risk to water quality as well a threat to infrastructure.

From: McNally, Dianne [mailto:mcnally.dianne@epa.gov]
Sent: Thursday, March 05, 2015 12:03 PM
To: Davis-Martin, James (DEQ); Bill Stack
Cc: Lucinda Power; Jennifer Volk; egiese@chesapeakebay.net ; Wood, DavidM; Lee Currey -MDE-
Subject: RE: Comments on Shoreline Management Report

James, thanks for keeping me in the loop.

Lee, I apologize if I you sent them out, but could you provide your suggested language?

James, just to ensure consistency, could your concern on how to address "unintended consequences" have implications on other BMP expert panels?

I think the WQGIT may benefit from somehow addressing these unintended consequences more clearly, especially since there are now new goals under the Bay agreement for such things as SAV, wetlands, stream health, fish passage, etc. The integration of multiple goals may be key.

My concerns with this specific report are that 40% of the panel dissented with the conclusions. We would benefit from addressing any unresolved concerns when the panel report is re-evaluated to address the nutrient crediting issue. I also would advocate for conducting research to demonstrate whether areas where erosion rates are less than 2 ft per year should be a qualifying condition. Also, is it relevant that the primary purpose of these practices are to protect property rather than to prevent N, P and SS from entering the Bay?

Thanks.

Dianne
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Bill - Thanks for you patience on this topic. James's argument against the "status quo" was a great approach to help make progress on this.

On Tue, Jul 14, 2015 at 8:38 AM, Bill Stack <bps@cwp.org> wrote:

Hi Lee,

I just want to thank you for your support at the WQGIT meeting yesterday. The outcome was much better than I expected and I think you and James helped resolve some important issues regarding the charge of the Expert Panel's.

Bill
William P. Stack, P.E.

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From: Lee Currey -MDE- [mailto:lee.currey@maryland.gov]
Sent: Thursday, June 18, 2015 6:11 PM
To: Bill Stack
Subject: Re: Tidal Shoreline Management Report

Bill - just spoke with DNR and we will approve the report on Monday but restate our concerns with this practice. Ultimately the authority to approve the practice is with the State.

Lee

On Thu, Jun 18, 2015 at 10:54 AM, Bill Stack <bps@cwp.org> wrote:

Hi Lucinda and James,

The July GIT meeting is approaching and I have attached the most recent draft of the Shoreline Management report for the GIT review for next month's meeting. I have highlighted edits that address concerns raised by the Army Corps (Chris Spaur) as well as Region 3 (Dianne McNally) and also highlighted edits based on conversations with Lee Curry and James that discuss the unintended consequences associated with Protocol 1 but ultimately allow the states to decide whether to credit these practices.

Lee recently informed me that DNR still has issues with this language. I suggest that we seek GIT approval and if there is still major dissention to at least approve Protocols 2-4.

Please let me know your thoughts. I will be on leave next week but will be checking emails periodically.

Bill

William P. Stack, P.E.

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Bill - thank you for your patience. I have reached out to DNR again to try and get consensus. We do not yet have internal agreement within the state. Below is my email to DNR...

From a pure accounting standpoint I am okay with the changes, but that means that the decision regarding the crediting (or rather "incentive") of this practice will be with the State. I still do not think the WQGIt document is the correct place to deny credit. Instead it should be with the authority of the State. The point of the WQGIt document is to identify the reductions that would likely occur and also identify any negative impacts to other goals. That said, I would like use to reach consensus on this prior to responding to the GIT

On Wed, Jun 17, 2015 at 9:22 AM, Bill Stack <bps@cwp.org> wrote: Hi Lee,

Have you heard back from DNR? I need to send the revisions to the GIT this week. If you feel that you will not be able to support the changes please let me know. If that is the case, my recommendation is to remove Protocol 1 and the Default Rate and seek approval for Protocols 2-4.

Any thoughts?

Thanks,

Bill

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From: Lee Currey -MDE- [mailto:lee.currey@maryland.gov]
Sent: Thursday, June 11, 2015 4:22 PM

To: Bill Stack
Subject: Re: FW: Comments on Shoreline Management Report

I have not. They have concerns but have not provided details.

Lee

On Thu, Jun 11, 2015 at 4:12 PM, Bill Stack <bps@cwp.org> wrote:
Hi Lee,

Have you heard anything from DNR? I will need to send out the revised document out next week for the July meeting.

Thanks,

Bill

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From: Lee Currey -MDE- [mailto:lee.currey@maryland.gov]
Sent: Friday, June 05, 2015 3:14 PM
To: Bill Stack
Subject: Re: FW: Comments on Shoreline Management Report

Bill,

I received your email and voice mail. My interpretation is that the State has the authority and flexibility to determine the policy as appropriate. I have sent this to DNR for their input and advised that we will not likely reach consensus on stronger language.

Thank you for your continued effort to reach consensus.

Lee

On Thu, Jun 4, 2015 at 11:09 AM, Bill Stack <bps@cwp.org> wrote: Hi Lee,

For some reason, I don't have any record of sending this. Are you available to talk tomorrow afternoon?

Thanks,

Bill

From: Bill Stack
Sent: Monday, June 01, 2015 2:15 PM
To: 'Lee Currey -MDE-'
Subject: RE: Comments on Shoreline Management Report

Hi Lee,

I had a conversation with James Davis Martin and went over the suggested edits that we discussed. While he concurs with the issues related to unintended consequences, he didn't want to tie local or state government's hands and wanted there to be flexibility.

It looks like we won't be on the next GIT agenda until July. I have also attached the latest draft so you can see where these edits appear.

Please take a look at the language changes suggested by him below and please let me know when you are available to discuss these.

Bill

Language suggested by Lee Curry : Footnote Table 1. Page 4.

For protocol 1 the Expert Panel recommends that credit should not be provided toward jurisdictional Bay restoration goals in areas where SAV is already present due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

Modifications suggested by James Davis Martin:

For protocol 1 the WQGIT recommends that state and local agencies consider whether credit should be given toward jurisdictional Bay restoration goals in areas where SAV is already present due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

Language suggested by Lee Curry: Page 9.

Further, for protocol 1 the Panel recommends that credit in areas where SAV is already present should not be provided toward jurisdictional Bay restoration goals due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

Modifications suggested by James Davis Martin:

In consideration of the Panel's concerns as expressed by the dissenting opinion (Appendix L), the WQGIT recommends that , for protocol 1, local and state jurisdictions consider whether sediment reduction credit should be given credit toward jurisdictional Bay restoration goals in areas where SAV is already present due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

Language suggested by Lee Curry. Page 52-53.

Therefore, to avoid encouragement of adverse impacts on SAV, the Expert Panel recommends that for Protocol 1, credit in areas where SAV is already present should not be provided toward jurisdictional Bay restoration goals due to the negative impact of shoreline erosion control practices on SAV. Jurisdictions and, or EPA may choose to not provide credit when other natural resources are adversely affected by the use shoreline management practices.

Modifications suggested by James Davis Martin:

Therefore, to avoid encouragement of adverse impacts on SAV, the Expert Panel recommended that for Protocol 1, local and state agencies should not issue credit toward jurisdictional Bay restoration goals in areas where SAV is already present due to the negative impact of shoreline erosion control practices on SAV. Further, jurisdictions and state agencies may choose not to provide credit when other natural resources are adversely affected by the use shoreline management practices. However, the WQGIT while agreeing with the concerns of the Expert Panel felt that these recommendations were too restrictive and instead recommends that local jurisdictions and states be given the flexibility on a case by case basis on whether a credit should be issued or not.

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From: Lee Currey -MDE- [mailto:lee.currey@maryland.gov]
Sent: Thursday, May 14, 2015 2:47 PM

To: Bill Stack
Subject: Re: Comments on Shoreline Management Report

Proposed language...

It is recommended that in areas where SAV is already present, credit toward jurisdictional Bay restoration goals not be provided due to the negative impact of shoreline erosion control practices on SAV (one of the TMDL water quality goals).

On Wed, May 13, 2015 at 4:49 PM, Bill Stack <bps@cwp.org> wrote:
Sounds good. I can give you a call or you can reach me on my 3205 extension.

William P. Stack, P.E.

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From: Lee Currey -MDE- [mailto:lee.currey@maryland.gov]
Sent: Wednesday, May 13, 2015 4:30 PM

To: Bill Stack
Subject: Re: Comments on Shoreline Management Report

Yes, does tomorrow afternoon at 2pm work?

On Wed, May 13, 2015 at 4:19 PM, Bill Stack <bps@cwp.org> wrote: Hi
Lee,

I just realized, I need to send the revised draft to the GIT by Monday to give everyone a chance to review by the June meeting. Do you have any time tomorrow to talk?

Thanks,

Bill

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From: Bill Stack
Sent: Friday, May 08, 2015 1:40 PM
To: 'Lee Currey -MDE-'
Cc: 'Power, Lucinda'; 'Neely Law' (nll@cwp.org)
Subject: RE: Comments on Shoreline Management Report

Hi Lee,

We are back up and running with the CBP and I have started to finalize comments from the GIT members. I have attached the most recent draft and highlighted the changes that I made to address the concerns from the GIT. I incorporated suggestions from your 2/20 email and addressed some of the concerns/suggestions in your 3/11 email. I would like to discuss these changes with you before I send them to the other GIT members.

Also, regarding the sand reduction factor, I changed the wording so that it is more sciencebased and supported by the modeling team. We left out the discussion on the technical merit in the initial draft to appease some members of the panel who were concerned about the unintended consequences. Regarding unintended consequences, the stream panel report also includes a section with pretty strong recommendations to prevent unintended consequences. I am not sure I will have the time to develop a table identifying the negative impacts to the Bay agreement outcomes or what the added value would be given the thorough discussion of these in the text but would like to hear more of what you had in mind.

I am pretty flexible next week after Tuesday so please let me know what works.

Thanks,

Bill

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Lets let Bill and Diane work out the details of the change to the exec summary, then Lucinda and I can review to ensure it meets the intent as discussed on the call. If all thumbs are up at that point, we can put the official approval stamp on it. If there is disagreement, we may need to run the new language by the GIT via email.

My understanding of the changes are pretty close to as described by Bill below. Some of the language in the additional sentence may need some tweaking… What we need to avoid is any implication that the unintended consequences will factor into the permitting approval process or other regulatory decisions. I also do not think the issue was only for protocol 1. Maybe something like "States will determine on a case by case basis when the unintended consequences outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit."

From: Power, Lucinda [mailto:power.lucinda@epa.gov]
Sent: Monday, July 13, 2015 4:59 PM
To: Bill Stack; Davis-Martin, James (DEQ)
Cc: Neely Law; Winters, Julie; Wood, DavidM
Subject: RE: Tidal Shoreline Management Report

Hi Bill,

I'll defer to James but I believe your email captures the discussion and follow up. THANK YOU for all of your efforts in moving this panel report forward and for James' excellent leadership today.

Lucinda

Lucinda Power

Chesapeake Bay Program Office
U.S. Environmental Protection Agency
(410) 267-5722

"Be the change you wish to see in the world." - Gandhi

From: Bill Stack [mailto:bps@cwp.org]
Sent: Monday, July 13, 2015 3:57 PM
To: Power, Lucinda; Davis-Martin, James (DEQ)
Cc: Neely Law; Winters, Julie; Wood, DavidM
Subject: RE: Tidal Shoreline Management Report

Hi Lucinda and James,

First, I would like to thank James for his leadership in getting the Expert Panel Report approved subject to the edits suggested by Dianne McNally. These edits involved moving the highlighted sections at the bottom of page 1 and top of page 2 to the first paragraph of the Executive Summary. This paragraph will also include a sentence stating that the states will issue approval for protocol 1 on a case by case basis after review of the potential unintended consequences on the effect of the practice on SAVs and/or other water quality goals.

I will follow-up with Dianne and assume if you concur with her edits, the report is considered final. Please let me know if I missed anything.

Thanks.

Bill

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From: Power, Lucinda [mailto:power.lucinda@epa.gov]
Sent: Tuesday, June 30, 2015 4:37 PM
To: Bill Stack
Subject: RE: Tidal Shoreline Management Report

Hi Bill,

Yes, David sent this out to the WQGIT membership on June 22. Please see the attached email.

Thanks and looking forward to your presentation on the July 13 call.

Lucinda

Lucinda Power
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U.S. Environmental Protection Agency
(410) 267-5722

"Be the change you wish to see in the world." - Gandhi

From: Bill Stack [mailto:bps@cwp.org]
Sent: Tuesday, June 30, 2015 4:00 PM
To: Power, Lucinda
Subject: RE: Tidal Shoreline Management Report

Hi Lucinda,

I am just checking to see if this was sent to GIT members. I am also working on a Power Point presentation for next meeting.

Bill

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From: Bill Stack
Sent: Thursday, June 18, 2015 11:01 AM
To: Power, Lucinda; 'Davis-Martin, James (DEQ)'
Cc: 'Lee Currey -MDE-'; 'Lewis Linker'; 'Neely Law' (nll@cwp.org); Julie Winters (winters.julie@epa.gov)
Subject: Tidal Shoreline Management Report

Hi Lucinda and James,

The July GIT meeting is approaching and I have attached the most recent draft of the Shoreline Management report for the GIT review for next month's meeting. I have highlighted edits that address concerns raised by the Army Corps (Chris Spaur) as well as Region 3 (Dianne McNally) and also highlighted edits based on conversations with Lee Curry and James that discuss the unintended consequences associated with Protocol 1 but ultimately allow the states to decide whether to credit these practices.

Lee recently informed me that DNR still has issues with this language. I suggest that we seek GIT approval and if there is still major dissention to at least approve Protocols 2-4.

Please let me know your thoughts. I will be on leave next week but will be checking emails periodically.

Bill

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Bill, thanks for your help on this report. Here are my proposed edits. Let me know if you have any questions.

Also, if you could clarify James Davis-Martin's statement below (highlighted), that would be helpful. My understanding is that impacts to SAV and wetlands should be considered in the 404 permitting process. I can loop around with James on this but thought you might have an answer.

Thanks.
Dianne

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mcnally.dianne@epa.gov

From: Bill Stack [mailto:bps@cwp.org]
Sent: Tuesday, July 14, 2015 9:20 AM
To: McNally, Dianne
Subject: FW: Tidal Shoreline Management Report

Hi Dianne,

I think you agreed to provide edits to the Expert Panel report and I have attached a WORD version for that purpose. James suggested the following language "States will determine on a case by case basis when the unintended consequences outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit." He also thought this language should apply to all of the protocols which makes sense.

Let me know if you would like to discuss this.

Thanks,

Bill

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From: Davis-Martin, James (DEQ) [mailto:James.Davis-Martin@deq.virginia.gov]
Sent: Monday, July 13, 2015 6:00 PM
To: Power, Lucinda; Bill Stack
Cc: Neely Law; Winters, Julie; Wood, DavidM
Subject: RE: Tidal Shoreline Management Report

Lets let Bill and Diane work out the details of the change to the exec summary, then Lucinda and I can review to ensure it meets the intent as discussed on the call. If all thumbs are up at that point, we can put the official approval stamp on it. If there is disagreement, we may need to run the new language by the GIT via email.

My understanding of the changes are pretty close to as described by Bill below. Some of the language in the additional sentence may need some tweaking… What we need to avoid is any implication that the unintended consequences will factor into the permitting approval process or other regulatory decisions. I also do not think the issue was only for protocol 1. Maybe something like "States will determine on a case by case basis when the unintended consequences outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit."

From: Power, Lucinda [mailto:power.lucinda@epa.gov]
Sent: Monday, July 13, 2015 4:59 PM
To: Bill Stack; Davis-Martin, James (DEQ)
Cc: Neely Law; Winters, Julie; Wood, DavidM
Subject: RE: Tidal Shoreline Management Report

Hi Bill,

I'll defer to James but I believe your email captures the discussion and follow up. THANK YOU for all of your efforts in moving this panel report forward and for James' excellent leadership today.

Lucinda

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(410) 267-5722

From: McNally, Dianne [mailto:mcnally.dianne@epa.gov]
Sent: Monday, July 20, 2015 2:54 PM
To: Davis-Martin, James (DEQ); Bill Stack
Cc: Power, Lucinda
Subject: RE: Tidal Shoreline Management Report

Thanks, Bill. I reviewed as well and it looks good to me. Thanks, James, for making the improvements to the language—reads better now.
Dianne

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215-814-3297 (phone) 215-814-2301
(fax) mcnally.dianne@epa.gov

From: Power, Lucinda
Sent: Monday, July 20, 2015 11:27 AM
To: Davis-Martin, James (DEQ); Bill Stack
Cc: McNally, Dianne; Neely Law; Winters, Julie; McNally, Dianne
Subject: RE: Tidal Shoreline Management Report

Bill, many thanks for moving this forward. I've reviewed the suggested changes and edits from Dianne and James and I'm fine with the revised language.

Lucinda

Lucinda Power
Chesapeake Bay Program Office
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(410) 267-5722

"Be the change you wish to see in the world." - Gandhi

From: Davis-Martin, James (DEQ) [mailto:James.Davis-Martin@deq.virginia.gov]
Sent: Monday, July 20, 2015 10:36 AM
To: Bill Stack; Power, Lucinda
Cc: McNally, Dianne; Neely Law; Winters, Julie; McNally, Dianne
Subject: RE: Tidal Shoreline Management Report

Here are a few suggested edits. In general the new language is fine, just a few word choice adjustments.

From: Bill Stack [mailto:bps@cwp.org]
Sent: Monday, July 20, 2015 9:49 AM
To: Davis-Martin, James (DEQ); Lucinda Power

Cc: McNally, Dianne; Neely Law; Julie Winters (winters.julie@epa.gov); McNally, Dianne
Subject: RE: Tidal Shoreline Management Report

Hi James and Lucinda,

Dianne McNally did an excellent job of adding the edits that we discussed at the GIT meeting to the report. I have highlighted these for your review. I have also highlighted where I added this language to other parts of the report for clarification purposes.

Please let me know if you concur with these edits. The last step would then be fixing the pagination for final publication.

Thanks,

Bill

Appendix M. Summary of Changes to the Report from the WTWQ and WQGIT

Watershed Technical Work Group (WTWG)

Revised Default Rate

The initial default rate for Tidal Shoreline Management Practices was based on the default rate for stream restoration practices. This was questioned by the WQGIT after the WTWG approved the Panel Report on February 13, 2015. After discussions with the Modeling Team the WTWG agreed that it would be more appropriate for the default rate to be based on the fine sediment loadings presented in Table 3 of the main body of the report. Since the practices that would be using the default rate would not be able to report all of the minimum data elements required of the protocols, there would be greater uncertainty associated with the structural integrity of these practices, therefore, the WTWG added a 50% slope stability factor to the fine sediment loadings (see discussion in Section 5.2.1.1 of the report). The default rate is summarized in Table 19 of Appendix C.

Revised Sediment Cap

The initial Expert Panel Report included a sediment cap for Protocol 1 to assure that the cumulative load reductions did not exceed the total loadings within the same water quality segment. The WTWG refined this to include caps at the River Segment. The specific language includes the following: The WTWG recommends that sediment reductions from all shoreline management practices within a land-river segment should not exceed the total fine sediment shoreline erosion load estimated to enter adjacent WQSTM tidal water cells. Note that one land-river segment can be adjacent to multiple tidal water cells. A listing of the fine sediment erosion loads estimated from each land-river segment can be found in the table below. You can also view these erosion estimates in state basin maps located at: https://archive.chesapeakebay.net/Modeling/gyactayo/Shore_erosion_maps/ A discussion can be found
in Appendix C.

Elimination of nutrient credit for Protocol 1.

The expert panel recommended that for Protocol 1 there would not be any reduction credit for TN and TP until the Modeling Workgroup has an opportunity to evaluate the availability of TN and TP in shoreline sediments. The Modeling Team will be asked to make recommendations on appropriate reductions following this analysis which would be amended into this report and subject to approval by the WTWG and WQGIT.

Water Quality Goal Implementation Team (WQGIT)

Adding Clarifying Language to address "Dissenting Opinion" and allowing states flexibility to address unintended consequences on a case by case basis.

The WQGIT added clarifying language throughout the report emphasizing the potential unintended consequence of impacting SAV's with the implementation of tidal shoreline practices. The following language was added to the Executive Summary. Similar text appears throughout the report. The Expert Panel Report categorically precluded credit for Protocol 1 in areas with existing or historical SAV beds. However, the WQGIT felt that the states should have flexibility on whether to approve or deny credit based on the potential for unintended consequences for all of the protocols. This was made clear in several sections of the report with the following language which was added to the Executive summary and can be found in other parts of the report.

While the resulting panel recommendations represent the majority view, significant dissent (40 % of the panel) exists regarding several of the main findings. The dissenting view opposed the use of Protocol 1 because the protocol could incentivize practices that would reduce fine grain as well as large grain (sediments). In short, the dissenters cited multiple studies that demonstrate the benefits of large grain sediments to wetlands and submerged aquatic vegetation areas (SAVs). The WQGIT recognizes that improving SAV is one of the water quality goals of the TMDL and that SAV, along with wetlands, are specific natural resources targeted for restoration by the Bay Program in the 2014 Bay Agreement. Therefore, to address this dissenting opinion, the WQGIT agreed to allow States to determine, on a case-bycase basis, when the unintended consequences of negative impacts to wetlands and SAVs caused by these shoreline management techniques, outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit. Local implementers are encouraged to review their projects with the jurisdictions prior to planning, design and installation of the shoreline management techniques to eliminate or minimize unintended consequences.

The purpose of this dissenting view is to summarize the areas of dissent and describe its logic such that those reviewing the report, including various Bay Program committees and boards as well as the general public, can be aware of the issues. However there was no dissention on the actual efficiency of the shoreline management practices which was the primary charge of the panel.

Allowed states the option on discounting projects for applying slope stability factor for Protocol 1 projects

Protocol 1 added a 50% discount to the sediment credit if the angle of repose of the project exceeded a slope stability threshold. The following language was modified to allow states greater flexibility when applying a stability factor. The Expert Panel felt that projects that were at risk for failure because of slopes greater than the angle of repose should be allowed only 50% of the credit allowed under Protocol 1. However, The WQGIT felt that local or state agencies should have the flexibility to give partial or not give any credit based on a site by site basis. The following language was added to Protocol 1.

Therefore, the shoreline management project should provide detailed bank stability analysis to the local reporting agency to document that no additional sediment and associated pollutants will enter the nearshore waters to include the following conditions: 1) the project was graded and vegetated so that the bank is stable and 2) excess sediment was removed offsite so that the sediment does not enter the nearshore waters. Bank analysis can demonstrate the site is stable with a minimum risk of erosion. This should be coordinated with the local reporting authority to ensure proper methods, reporting, and requirements are done and are accepted by that authority so that the project meets this basic qualifying condition. The local or state agency may decide *not to issue the credit based on the information regarding site slope and stability assessment that is provided.*

WQGIT agreed to allow States to determine, on a case-by-case basis, when the unintended consequences of negative impacts to wetlands and SAVs caused by these shoreline management techniques, outweigh the benefits, in which case the practice will not be reported to the Bay Program for model credit.

This language was added as a caveat for WQGIT approval which would allow the states flexibility on whether to credit practices that could have unintended consequences (affect SAV beds). The WQGIT felt the language in the earlier drafts of the Expert Panel report were overly prescriptive in an attempt to address the “dissenting opinion” of panel members, however after much debate, WQGIT members felt there were local regulations in place (e.g., 404 permits) that would safeguard against many of these unintended consequences.