Recommendations of the Expert Panel on Shoreline ~~Erosion Control~~ \/ Management

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

Submitted by:
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Submitted to:
Urban Stormwater Work Group
Chesapeake Bay Partnership

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Insert Final Date here

Cheston Point, MD (top), a retreating shoreline in VA (bottom left) and Pretty Marsh in VA (bottom right). Pictures courtesy of Jana Davis and Pam Mason.

Need for the Panel - Update TN, TP, and TSS removal rates based on best available information

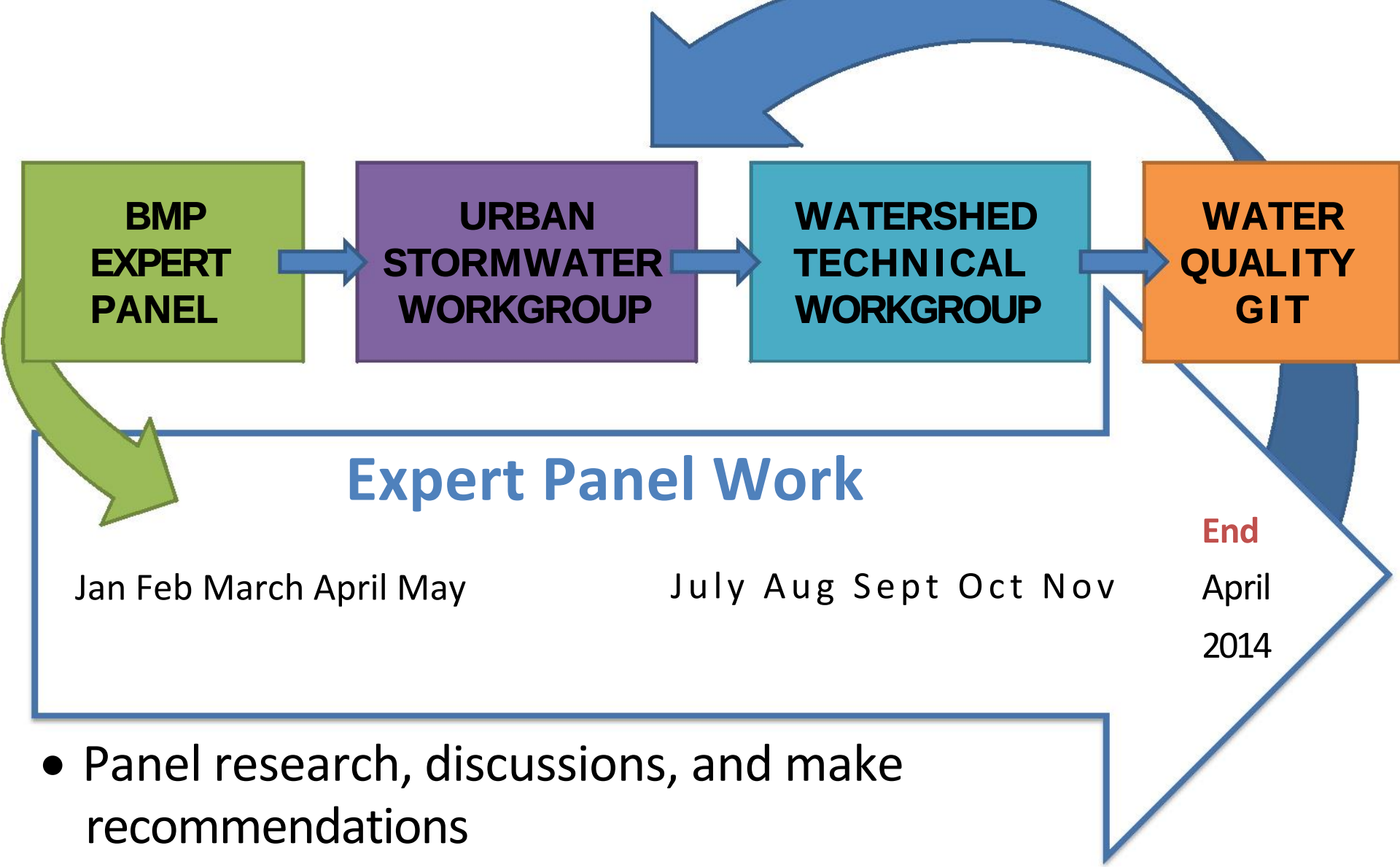
Shoreline Erosion Loading Rates

Source	TN (lb per foot per year)	TP (lb per foot per year)	TSS (lb per foot per year)
Ibison, 1990	1.65	1.27	7,000
Ibison, 1992	0.81	0.66	2,800
Proctor, 2012 (WEG)	na	0.38 or 0.29	1,300
MDE, 2011*	0.16	0.11	451
BaCo (mean)	0.36	0.23	974
CBP (2003)	0.02	0.0025	2
CBP (July 2013)	0.20	0.068	54.25

*MDE data based on Baltimore Co. DEPS analysis of 23 individual shoreline restoration projects completed by Baltimore Co. DEPS Capital Projects and Operations. Median values were used. (Nathan Forand presentation to the SEC panel on 2/25/13)

Shoreline Management Panel Members

Panelist	Affiliation
Jana Davis, Ph.D.	CBT/HGIT
Kevin DuBois, PWS, PWD City of	Norfolk, VA
Jeff Halka	MD Geologic Survey, retired
Scott Hardaway, P.G.	VIMS Shoreline Studies Program
George Janek	USACE, Norfolk District
Lee Karrh	MD DNR
Eva Koch, Ph.D.	UMCES
Lewis Linker	CBPO
Pam Mason	VIMS Center for Coastal Resource Management
Ed Morgereth, MS	ISS Biohabitats
Daniel Proctor, P.E.	Stantec (formerly Williamsburg Environmental Group)
Kevin Smith	MD DNR
Bill Stack, P.E.	CWP, CBPO
Steve Stewart/Nathan Forand	Baltimore County Dept. of Environmental Protection and Sustainability
Bill Wolinski, P.E.	Talbot County Dept. of Public Works



- Panel research, discussions, and make recommendations
- Present to EPA CBPO workgroups

Panel process information is online at:

- http://stat.chesapeakebay.net/?q=node/130&quicktabs10=3
- http://www.chesapeakebay.net/documents/Nutrient-SedimentControlReviewProtocol07162013.pdf

Shoreline Management Expert Panel Charge

- Evaluate how shoreline practices are modeled, review literature, develop pollutant removal, and reporting units
- Provide a definition, geographic boundary, and qualifying conditions
- Recommend reporting, tracking, and verification procedures

Rationale, Methods, and Examples for New Shoreline Management Protocols

- Literature review to support shoreline management protocols
  - Reviewed over 200 publications, group discussions, heard from experts, and used best professional judgment
- The science and past CBPO EPA panel precedent support the panel's recommendations for pollutant load reductions for shoreline management practices that:
  - prevent erosion and associated sediment and nutrients from entering the Bay (Protocol 1: Prevented Sediment); and
  - shoreline management practices that incorporate vegetation
    - promote denitrification and remove nitrogen (Protocol 2: Denitrification);
    - promote accretion and sedimentation that remove sediment and phosphorus (Protocol 3: Sedimentation); and
    - promote vegetative uptake and associated nutrient removal (Protocol 4: Marsh Redfield Ratio).

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

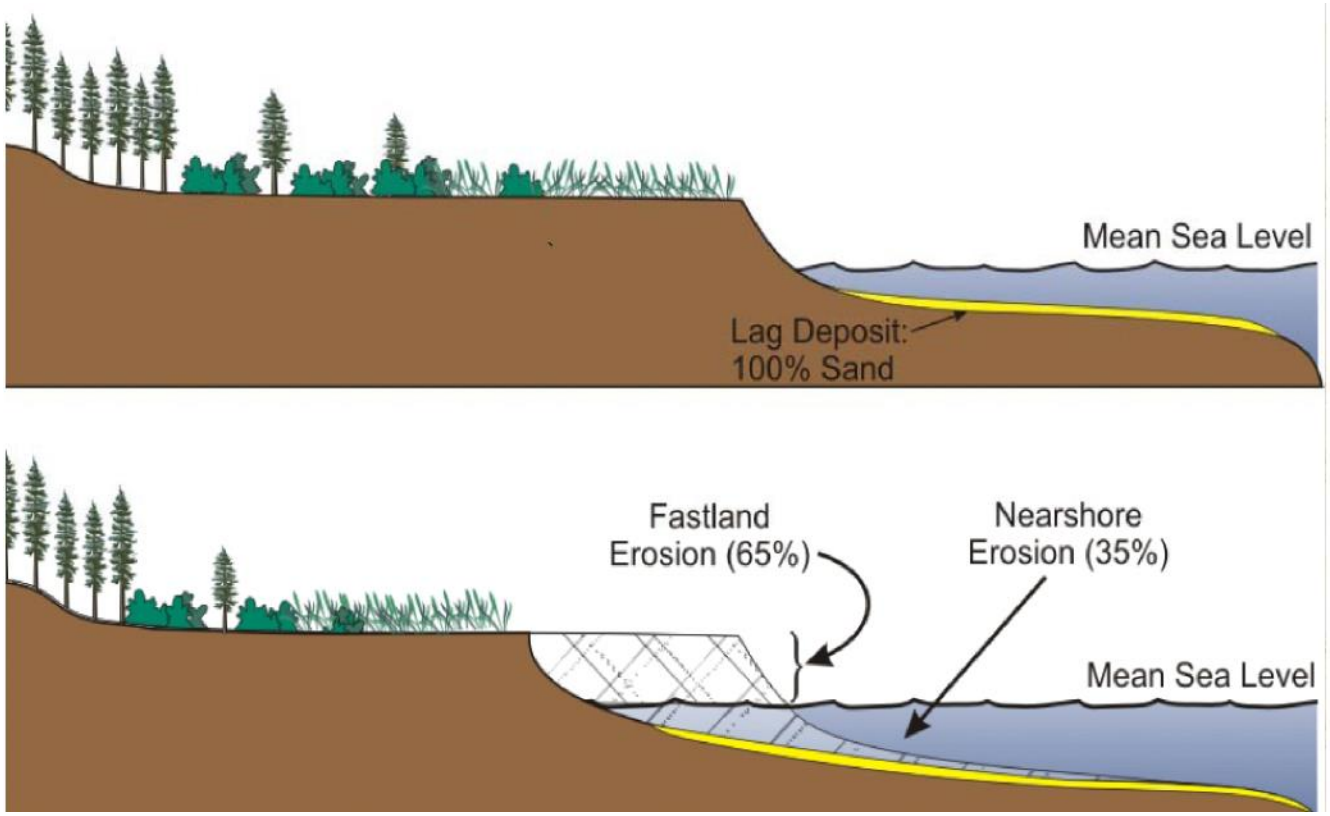
Protocol	Name	Units	Pollutants	Reduction Rate
1	Prevented Sediment	Pounds per year	Sediment TN, TP	• Measured TSS, TN and TP content in sediment prevented. • Calculated based on shoreline erosion with reductions for sand content and bank instability
2	Denitrification	Pounds per year	TN	• Measured TN removal for denitrification rate associated with vegetated area. • 85 lbs TN/acre/yr
3	Sedimentation	Pounds per year	Sediment and TP	• Measured TSS and TP removal rates associated with vegetated area. • 6,959 lbs TSS/acre/yr • 5.289 lbs TP/acre/yr
4	Marsh Redfield Ratio	Pounds	TN, TP	• Measured TN and TP removal rates associated with vegetated area. • Note that this is a one-time credit. • 205 lbs TN/acre • 9 lbs TP/acre

Protocol 1. Prevented Sediment

- Shoreline erosion is a sediment source to the Bay
- Shoreline management practices prevent that sediment from entering the Bay and also protect coastal property
- *To reduce unintended consequences,* refinements were made to address the sand content of the prevented sediment, the bank instability, and a state basin cap
- Precedent for this protocol in the Urban Stream Restoration panel

Unprotected shore erosion is a major Chesapeake Bay sediment source

(Langland and Cronin, 2003)



Erosion of fastland from unprotected shorelines represents 65% of the total load; nearshore erosion represents 35%.

Expert Panel Definition

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

Living Shorelines

Structural practices

low structure → high structure

Non-structural living shorelines:
Projects that include natural habitat elements only, such as vegetation, oyster reef, coarse woody debris, and sand.

Non-structural living shoreline

Hybrid living shorelines:
Projects that include natural habitat elements such as vegetation, oyster reef, and sand, as well as some hard structures such as stone sills or breakwaters

Low-structure hybrid living shoreline

Medium-structure hybrid living shoreline

Projects that include the following practices without a natural habitat component:
- Bulkheads/Seawalls
- Revetments
- Breakwaters
- Groins/jetties

Structural erosion control practice

Rationale for Basic Qualifying Conditions

VIMS, Gloucester Point, VA

- Use a watershed approach for preservation and restoration
- Shoreline management approach (Appendix D)
- Shoreline management should be implemented only in areas where needed and where appropriate
  - Common benchmarks(CBF, 2007; See also MDE, 2008 and Appendix G)
  - Urban considerations – available space for practice, legacy pollution at the site

Rationale for Basic Qualifying Conditions VA

VIMS, Gloucester Point,

- **Sea Level Rise**
  - Threat to coastal areas and need for better designs (Appendix F)
- **SAV Habitat**
  - Chesapeake Bay SAV goals and Chesapeake Bay TMDL intersect
  - Horizontal shoreline erosion of 2 ft/yr vetted with panel as a basic qualifying condition(Karrh et al., 2011); did not pass
  - Hard armor negatively impacts SAV

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**	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 When a marsh fringe habitat (a or b) or beach/dune habitat (c) is created, enhanced, or maintained.
Revetment AND Breakwater system without a living shoreline	The site is currently experiencing shoreline erosion. The site was graded, vegetated, and excess sediment was removed or used.[2] AND A living shoreline is not technically feasible or practicable as determined by substrate, depth, or other site constraints. AND When the breakwater footprint would not cover SAV, shellfish beds, and/or wetlands.
Bulkhead/Seawalls	The site is currently experiencing shoreline erosion. AND 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.

Protocol 1. Prevented Sediment

- Step 1 – Estimate shoreline sediment erosion rate
- Step 2 – Convert shoreline erosion to nutrient loading rate
  - V(volume) = L (length) E (erosion rate) B (bank height)
  - Default values:
    - Bulk density = 93.6 lb/ft^3
    - 0.57 pounds TN/ton sediment
    - 0.41 pounds TP/ton sediment
- Step 3 – Estimate shoreline restoration efficiency
  - Used 100% effectiveness

Site specific sampling can be used

Sand and Bank Instability Reductions for Prevented Sediment

- Sand Reduction for Prevented Sediment

State	Loading (kg/m/d)			Sand Reduction Factor
	Total	Fines	Coarse	
Maryland	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) (Cerco, 2010).

- Bank Instability for Prevented Sediment
  - Angle of repose and unconsolidated bank sediments (Clark et al. 2004)
  - Subtract 50% from prevented sediment

Pollutant Load Reduction Cap

Shoreline Management Load Reductions per state-basin should not exceed one-third of the WQSTM fine sediment shore erosion load to the state basin:

Intended to prevent implementation of shoreline practices in high numbers and/or in areas not suited for the shoreline management practices.

However, It's unlikely that any state basin will exceed 1/3 of the pollutant loads using shoreline management because 85% of the Ches. Bay shoreline is privately owned and 1/3 of the Ches Bay shoreline is already protected.

Any state basin exceeding 1/3 of its pollutant load will be assessed on a case by case basis by EPA CBPO.

Source: Tony Watkinson VIMS, Gloucester Point, VA

Protocol 2. Denitrification

- Tidal marsh, especially fringe tidal marsh, are active denitrification removal areas (Greene, 2005; Merrill, 1999, Merrill and Cornwell, 2002, and others)
- Focus on fringe tidal marshes here and not larger wetland systems
- Literature review of 18 studies, summarized each study took the median denitrification rate, and converted to pounds TN/acre/yr
- This pollutant removal rate is based on the net vegetation area increase
- Result
  - 85.02 pounds TN/acre/yr
- See also Appendix H

Protocol 2. Denitrification

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

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

Source: VA DCR

Protocol 3. Sedimentation

- Tidal marsh vegetation traps and accretes sediments
- Marsh edge is similar to living shoreline area and has high accretion
- Summarized studies in the Bay and other relevant areas that quantified sedimentation in the top 10 cm for sediment core, horizontal marker, and sediment flux studies
- Literature review of 22 studies, summarized each study took the median sedimentation rate and converted to pounds TSS/acre/yr and TP/acre/yr
  - Conservative bulk density used was 0.3895 g/cm^3 (Callaway et al. (2012)
- Result
  - 6,959 pounds TSS/acre/yr
  - 5.289 lbs TP/acre/yr
- See also Appendix I

Protocol 3. Sedimentation

- ***Step 1. Determine the total post construction area of the net increase in marsh plantings and convert to acres.***
- ***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 5.289 lbs total phosphorus/acre/yr***

Source: VA DCR

Protocol 4. Marsh Redfield Ratio

- Tidal marsh vegetation ties up TN and TP that would otherwise enter the Bay
- Summarized studies in the Bay and other relevant areas that quantified marsh Redfield ratio and aboveground and belowground production
- Literature review over 50 studies, summarized each study took the mean aboveground and belowground biomass, and converted to pounds TN/acre/yr and TP/acre/yr
- This pollutant removal rate is based on the net vegetation area increase
- Result
  - A ONE TIME CREDIT REALIZED IN YEAR ONE ONLY
  - 205 pounds TN/acre/yr
  - 9 lbs TP/acre/yr
- See also Appendix J

Protocol 4. Marsh Redfield Ratio

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

- *Step 2. Multiply the acres of tidal marsh planting by the unit marsh Redfield ratio value (205 pounds total nitrogen/acre and 9 pounds total phosphorus/acre).*

Examples

- Basic qualifying conditions examples in Table 12
- Maryland and two Virginia examples provided
  - See Appendix K Sediment Sampling Protocol

MD Example

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)[1]	Year 1 Total Pollutant Load Reduction (lb/yr)[2,3]
TN	233	153	NA	369	755
TP	168	NA	9.520	16.2	193
TSS	450,070	NA	12,526	NA	462,596

[1]Marsh Redfield Ratio pollutant load reduction if a one-time credit.

[2]The TN and TP totaled here are for the first year and include the one-time credit for the Marsh Redfield Ratio. In subsequent years there will be no TN or TP pollutant load reduction for this protocol.

[3] 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.

Accountability and Unintended Consequences

- Practices must be accounted for and verified to maintain the function and pollutant load reductions
- Reporting, tracking, and verification
  - Develop verification principles in the future
- Units for local government to report
- Expected values
  - See 5.3 Examples

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

Protocol	Parameters to Report	Notes
All Protocols	• Practice type • Year installed • Location coordinates • 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
Protocol 1. Prevented Sediment	• Length (ft) • Height of project (ft) • Erosion rate (ft/yr)	
Protocol 2. Denitrification	• Protocol 1 parameters • Vegetation surface area (acre) o Net increase of vegetation	
Protocol 3. Sedimentation	• Protocol 1 parameters • Vegetation surface area (acre) o Net increase of vegetation	
Protocol 4. Marsh Redfield Ratio	• Protocol 1 parameters • Vegetation surface area (acre) o Net increase of vegetation	

Accountability

- Tracking
  - Name, location, permit number, county, location, practice type, and vegetation area
- Verification
  - Initial performance verification – responsible crediting party provide post construction documentation to the reporting agency
- Duration of shoreline management credit
  - 5 years

Accountability

- Reporting to the state
  - Report to and coordinate with state agency
- Record keeping
- Future field verification to ensure project performance
  - Credit agency inspect every 5 yrs
- Previously installed and/or non-conforming projects
  - If installed in the last 5 yrs and conform to new standards, projects can receive these new credits
  - New protocols must be used if higher or lower than “old credit”
- Down-grading
  - Must bring project up to standards w/in one year of inspection/non compliance
  - Annual reporting for non MS4 communities

Unintended Consequences

- **Unintended consequences**
  - **Basic qualifying conditions**
  - **Sand reduction factor**
  - **Bank instability/angle of repose**
  - **State basin cap**
  - **Use state policy to ensure best practices are implemented in the watershed and on the shoreline**
  - **Protect habitat (e.g., SAV, fish, etc.)**
  - **Use a comprehensive shoreline management approach (Appendix D)**

Shady Cove

Source: Jana Davis, CBT

Shoreline Management Habitat Impacts Dissenting Document

- Tidal wetland losses
  - 18% of coastal wetlands lost are tidal salt marsh (Stedman and Dahl, 2008)
- Hard shore armor impacts
  - Past and future hard armor has negative impacts
    - Physical, chemical, ecological communities
- Not all sediment is “bad”
  - Ecological trade offs made
  - Large grained sediments (sand) provide geologic and ecologic functions, such as SAV

Future Research and Management Needs (see Table 18)

- Panel's confidence in recommendations
  - Scientific gaps in shoreline management
    - Shoreline erosion rates
    - Shoreline management practice effectiveness
    - Habitat protection and restoration
  - Proposed timeframe for panel recommendations review and update
    - Every 2 years
  - Proposed refinements for CBWM or WQSTM next phase
    - Better simulation needed for land-river segments adjacent to tidal waters
    - See Appendix C Technical Requirements for Entering Practice into Scenario Builder

Next Steps…

- April 15, 2014: Urban Stormwater Workgroup (USWG) approved panel recommendations
- May 8, 2014: Preliminary Presentation to the Watershed Technical Workgroup.
- June 5, 2014: Formal Presentation to Watershed Technical Workgroup. Review panel recommendations and dissenting view document recommendations (remove Protocol 1 - prevented sediment). Based on Dissenting View Document, MD DNR's opposition to protocol 1, and the USWG discussion on the subject. Vote (yes/no) on the panel recommendations
- Date TBD: Present to the Water Quality Goal Implementation Team to get approval for the recommendations to be input into the Chesapeake Bay modeling tools and planning tools (e.g., CAST, VAST, MAST)

The full panel report can be found here: http://www.chesapeakebay.net/calendar/event/21151

Questions/Comments

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