

## Stream Restoration Protocols For Meeting Sediment and Nutrient Goals in the Chesapeake Bay



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Expert Panel Meeting - AGENDA  
October 8-9, 2014

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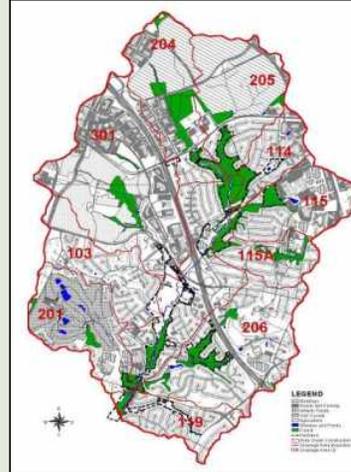
## The CBP Process for BMP Crediting: TP, TN, TSS

- CBP ranks BMPs in order of importance and assembles Expert Panel
- Expert panel uses literature, new data and best professional judgment to develop sediment and nutrient reduction credits
- Long CBP Committee approval process



## Comprehensive Watershed Restoration Approach

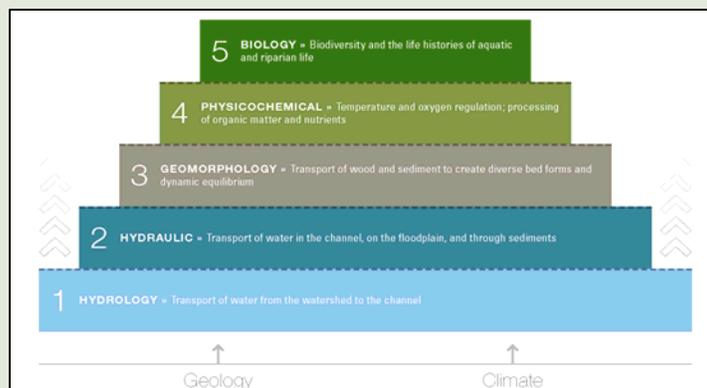
- Panel endorsed a comprehensive watershed approach to install restoration practices in the uplands, the stream corridor, and in appropriate settings, within the stream itself.
- No current science to recommend what proportion of practices should be applied to uplands vs. stream corridor.



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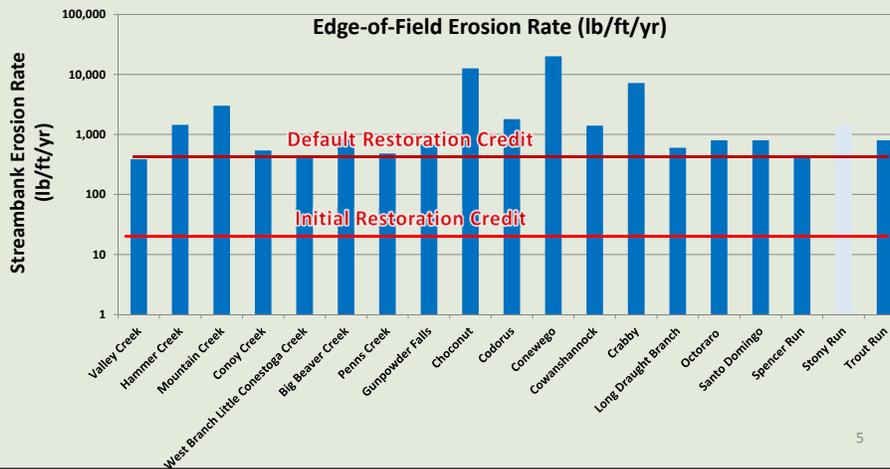
## Stream Functions Pyramid

A hierarchical framework illustrating the relative relationship of stream functions and parameters that can be used to describe those functions



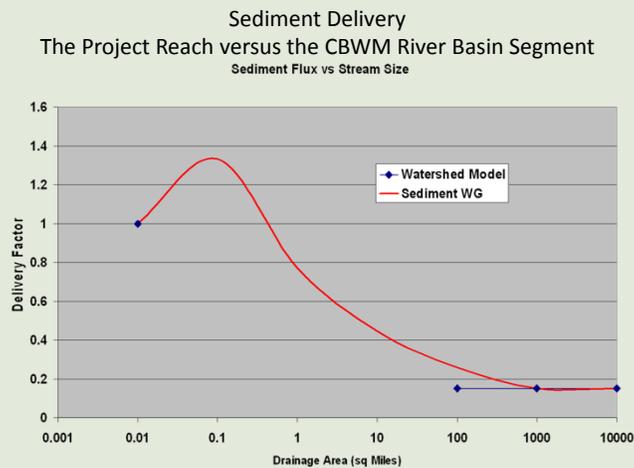
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## Why the initial credit needed to be changed



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## How Much Sediment Makes its way to the Bay?



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## Default Rate

Used for planning purposes and for projects that do not conform to the protocol requirements.

Edge-of-Stream Default Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)			
Source	TN	TP	TSS*
<b>Revised Default Rate</b>	0.075	0.068	44.88 non-coastal plain 15.13 coastal plain
<small>Derived from six stream restoration monitoring studies: Spring Branch, Stony Run, Powder Mill Run, Moore's Run, Beaver Run, and Beaver Dam Creek located in Maryland and Pennsylvania                      *To convert edge of field values to edge of stream values, a sediment delivery ration (SDR) was applied to TSS. The SDR is 0.181 for non-coastal plain streams and 0.061 for coastal plain streams.</small>			

TP reduction from 1,000 ft. of stream restoration = Load from 40 acres of impervious cover!

## What is Stream Restoration?

Refers to any NCD, RSC, LSR or other restoration project that meets the **qualifying conditions for credits**, including **environmental limitations** and **stream functional improvement**.

The Panel agreed that any single design approach was not superior to the others, as any project can fail if it is inappropriately located, assessed, designed, constructed, or maintained.

## Stream Restoration Protocols



1. Prevented sediment approach



2. In-stream denitrification



3. Floodplain reconnection



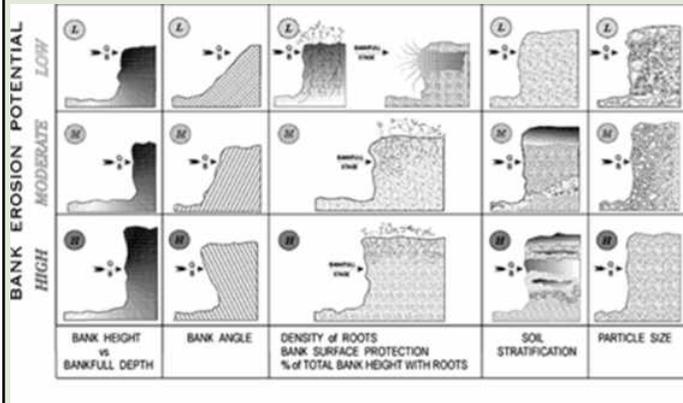
4. The "tweener" Dry Channel RSC <sup>9</sup>

## Protocol 1: Credit for Prevented Sediment during Storm Flow

- *Estimate stream bank erosion rate from monitoring or empirical relationships*
- *Convert erosion rates to loadings*
- *Multiply sediment load by TN and TP from concentrations from stream bank*
- *Use conservative 50% reduction efficiency based on local data, literature values or anecdotal observations by practitioners*

# Protocol 1: Credit for Prevented Sediment during Storm Flow

Step 1. Estimate Stream Sediment Erosion Rates Using the BANCS Method

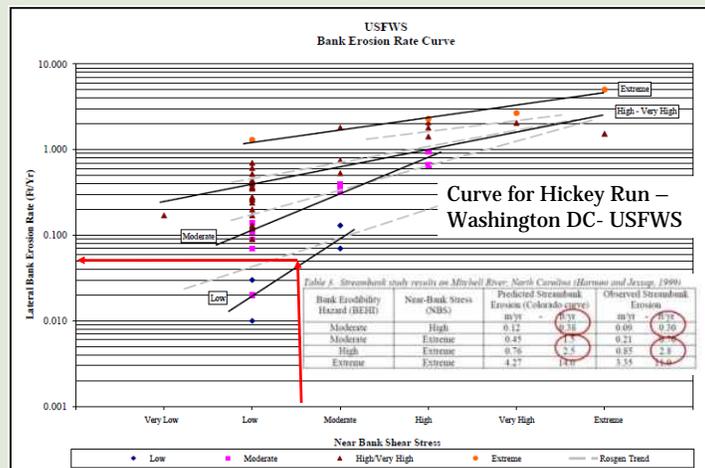


Streambank Characteristics used to develop BEHI



# Protocol 1: Credit for Prevented Sediment during Storm Flow

Regional Curve for Determining "R" in equation:  $S = \sum(C \times A \times R)$



## Protocol 1: Credit for Prevented Sediment during Storm Flow

Stony Run Before  
and After Surveys



High BEHI  
and NBS



Low BEHI  
and NBS

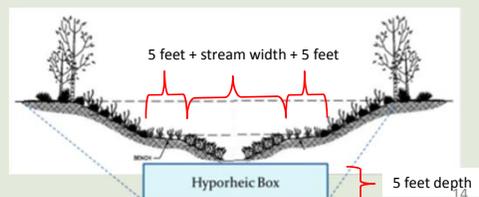


## Protocol 2: Credit for Denitrification in the Hyporheic Zone during Base Flow

**Step 1.** Determine the total post construction stream length that has been reconnected using the bank height ratio of 1.0 or less (for NCD) or the 1.0 inch storm (other design approaches that do not use the bank full storm)

**Step 2.** Determine the dimensions of the hyporheic box

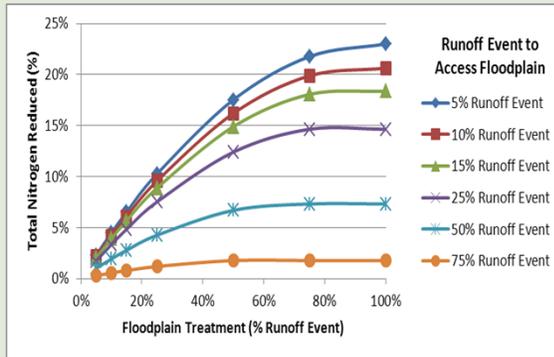
**Step 3.** Multiply the hyporheic box mass by the unit denitrification rate



## Protocol 3: Credit for Floodplain Reconnection

**Step 1.** Estimate the floodplain connection volume

**Step 2.** Estimate the N and P removal rate attributable to floodplain reconnection (using Jordan 2007 study)



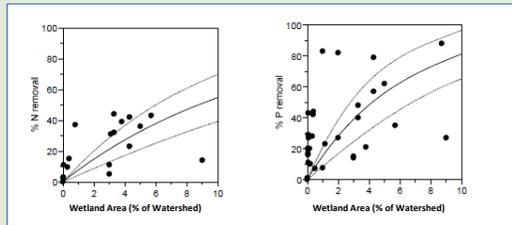
Photos courtesy of Jeff Hartranft, PADEP

## Protocol 3: Credit for Floodplain Reconnection

The maximum ponded volume in the floodplain that receives credit is 1 foot to ensure interaction between runoff and wetland plants.

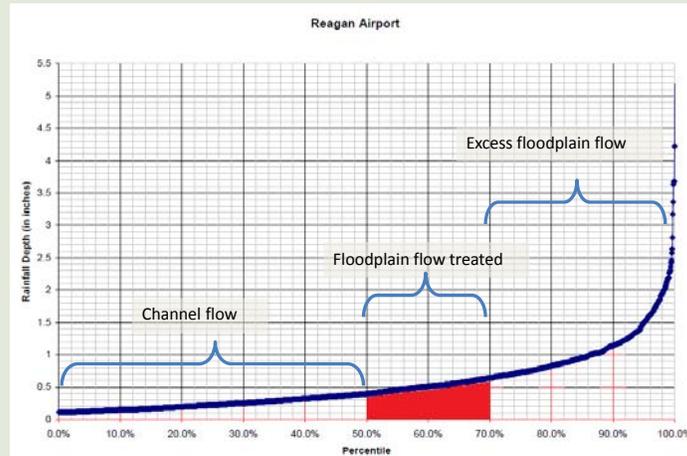
There is a minimum watershed to floodplain surface area ratio of 1% to ensure adequate hydraulic detention time.

Relationship between nutrient removal and ratio of wetland area to watershed area



Study by Jordan, Smithsonian Environmental Research Center, as published in Weammert and Simpson, 2009. The proportion of TN and TP removed increases with the proportion of wetland area, but the rate of increase declines as the proportion of wetland area increases. Thus, the additional benefit of adding more wetland area gradually diminishes.

### Protocol 3: Credit for Floodplain Reconnection



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### How do stream restoration projects compare to other BMPs?

Cost-Effectiveness of Urban Stormwater BMPs			
BMP	Cost Effectiveness (\$/lb)		
	TN	TP	TSS
Bioretention (new - suburban), A/B soils, no underdrain	\$339.00	\$2,934.83	\$5.82
Bioretention (new - suburban), C/D soils, underdrain	\$1,084.81	\$5,543.56	\$9.53
Bioretention (retrofit, highly urban C soils)	\$2,078.97	\$12,500.51	\$22.25
Bioswale (new)	\$309.13	\$2,653.91	\$5.23
Dry Detention Ponds (new)	\$4,597.20	\$21,143.16	\$44.43
Dry Extended Detention Ponds (new)	\$1,149.30	\$10,571.58	\$7.41
Filtering Practices (sand, below ground)	\$1,065.38	\$4,940.56	\$7.04
Forest Buffers	\$150.86	\$1,851.00	\$7.66
<b>Urban Stream Restoration (recommended 2014 default efficiencies)</b>	<b>\$696.86</b>	<b>\$768.59</b>	<b>\$1.16</b>
Illicit discharges- correction of cross-connections	\$17.70	\$70.79	\$6.69
Illicit discharges- sewer repair	\$8.86	\$35.43	\$0.89

Source: Cost-Effectiveness Study of Urban Stormwater BMPs in the James River Basin, 2013. CWP

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## Qualifying Conditions, Verification, and Reporting requirements

- Stream restoration project must provide functional lift and be part of a comprehensive watershed management plan.
- Credit is renewed based on a 5 yr field performance inspection that verifies the project still exists, is adequately maintained and operating as designed.
- Protocols have to be reapplied and credits adjusted if changes occur in watershed (e.g., BMP implementation)

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## Next Steps

- Updates for Phase 6 of the Chesapeake Bay Watershed Model.
  - Modeling streams as a land cover?
  - Accounting for nutrient loss associated with deposition
  - Better apportioning of watershed loading to stream channels

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**Questions?**