Stream Restoration Crediting for Meeting Sediment and Nutrient Goals in the Chesapeake Bay

CENTER FOR WATERSHED PROTECTION

COG Stream Restoration Technical Session

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Chesapeake Bay Program
A Watershed Partnership

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Sediment Reduction and Stream Corridor Restoration Analysis, Evaluation and Implementation Support to the Chesapeake Bay Program Partnership

I. Provide Modeling Support

- Estimate upland and in-stream sediment contributions through a scientific literature review and data analysis.

II. Coordinate Partnership Scientific Input

- Urban Stream Restoration Expert Panel
- Shoreline Erosion Control Expert Panel
- Urban Filter Strip/Stream Buffer Upgrade Expert Panel

III. Programmatic Evaluation, Reporting and Verification

- Stream restoration verification principles
- STAC workshop - Designing Sustainable Stream Restoration Projects within the Chesapeake Bay Watershed
- Stream health workgroup

Expert Panel on Stream Restoration

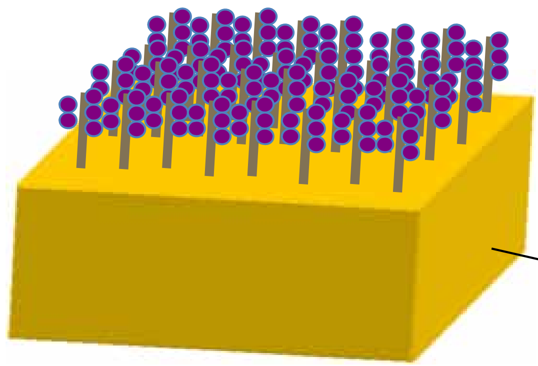
Expert BMP Review Panel for Urban Stream Restoration	
Panelist	***Affiliation***
Deb Cappuccitti	Maryland Department of Environment
Bob Kerr	Kerr Environmental Services (VA)
Matthew Meyers, PE	Fairfax County (VA) Department of Public Works and Environmental Services
Daniel E. Medina,Ph.D, PE	Atkins (MD)
Joe Berg	Biohabitats (MD)
Lisa Fraley-McNeal	Center for Watershed Protection (MD)
Steve Stewart	Baltimore County Dept of Environmental Protection and Sustainability (MD)
Dave Goerman	Pennsylvania Department of Environmental Protection
Natalie Hardman	West Virginia Department of Environmental Protection
Josh Burch	District Department of Environment
Dr. Robert C. Walter	Franklin and Marshall College
Dr. Sujay Kaushal	University of Maryland
Dr. Solange Filoso	University of Maryland
Julie Winters	US Environmental Protection Agency CBPO
Bettina Sullivan	Virginia Department of Environmental Quality
Panel Support	
Tom Schueler Bill Stack	Chesapeake Stormwater Network (facilitator) Center for Watershed Protection (co-facilitator)
Other Panel Support: Russ Dudley – Tetra Tech, Debra Hopkins – Fish and Wildlife Service, Molly Harrington, CBP CRC, Norm Goulet, Chair Urban Stormwater Work Group, Gary Shenk, EPA CBPO, Jeff Sweeney, EPA CBPO, Paul Mayer, EPA ORD	

The Panel Process

- Outlined in the BMP Review Protocol (WQGIT, 2010)
- BMP Expert Panel → reviews existing research → set of recommendations
- 7 calls, 2 workshops, 5 drafts over 12 months
- Product: Technical Memo and 5 Appendices

The Agriculture Work Group, Watershed Technical Workgroup and Stream Habitat GIT is also actively involved in the review process.

Scale in Phase 5 - Sediment



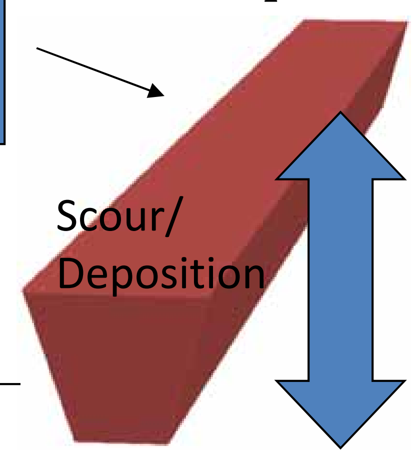
Edge of Field
Expected loads from one acre

BMP Factor

Land Acre Factor

Delivery Factor

Edge of Stream
60-100 sq miles

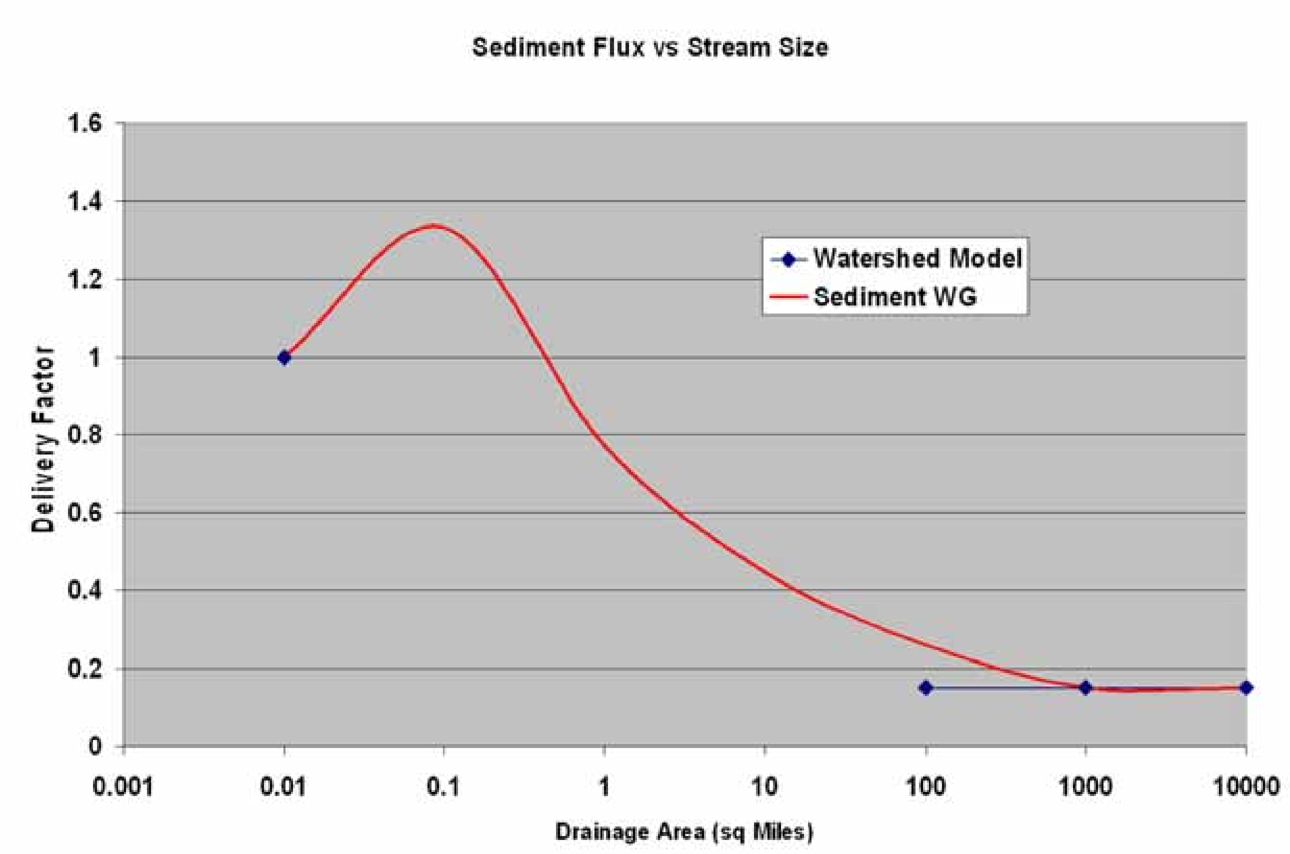


Calibrated to core trend stations

In Stream Concentrations

How Sediment and Nutrients are Simulated in the CBWM

Sediment Delivery
The Project Reach versus the CBWM River Basin Segment



Review of the Old Rate

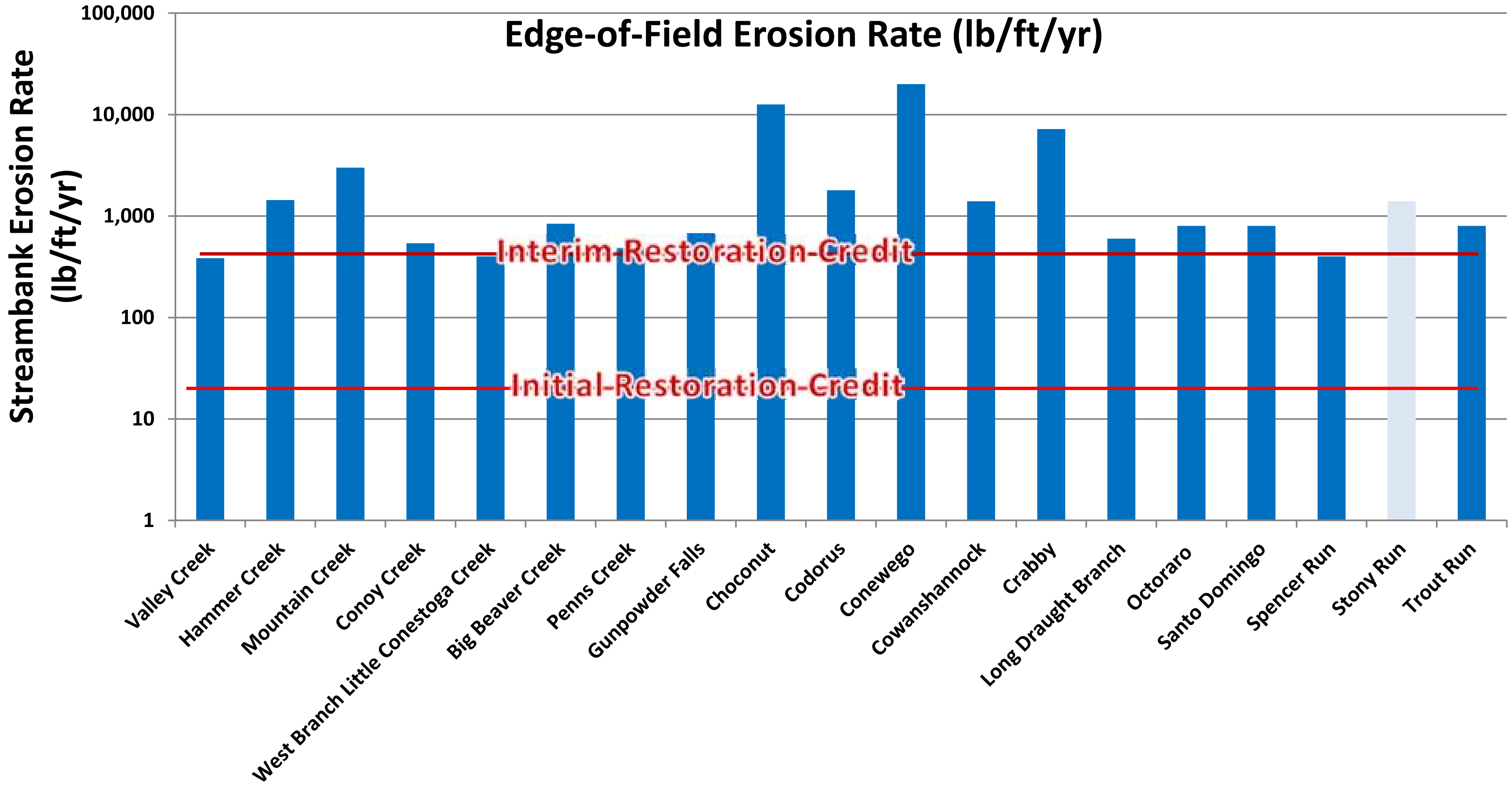
Initial CBP-Approved Stream
Restoration Credit (2003)

Removal Rate per Linear Foot of Qualifying Stream Restoration			
Source	TN	TP	TSS
Spring Branch N=1	0.02 lbs	0.0035	2.55 lbs
At some point applied to non-urban stream restoration projects.			

Approved Interim Rate

Edge-of-Stream 2011 Interim Approved Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)			
Source	**TN**	**TP**	**TSS***
New Interim CBP Rate	0.20	0.068	310 (54.2)
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 *The removal rate for TSS is representative of edge-of-field rates and is subject to a sediment delivery ratio in the CBWM to determine the edge-of-stream removal rate. Additional information about the sediment delivery ratio is provided in Appendix B.			

Why the initial credit needed to be changed and a universal restoration credit doesn't make sense



Protocol 1: Credit for Prevented Sediment during Storm Flow

This protocol provides an annual mass nutrient and sediment reduction credit for qualifying stream restoration practices that prevent channel or bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream.

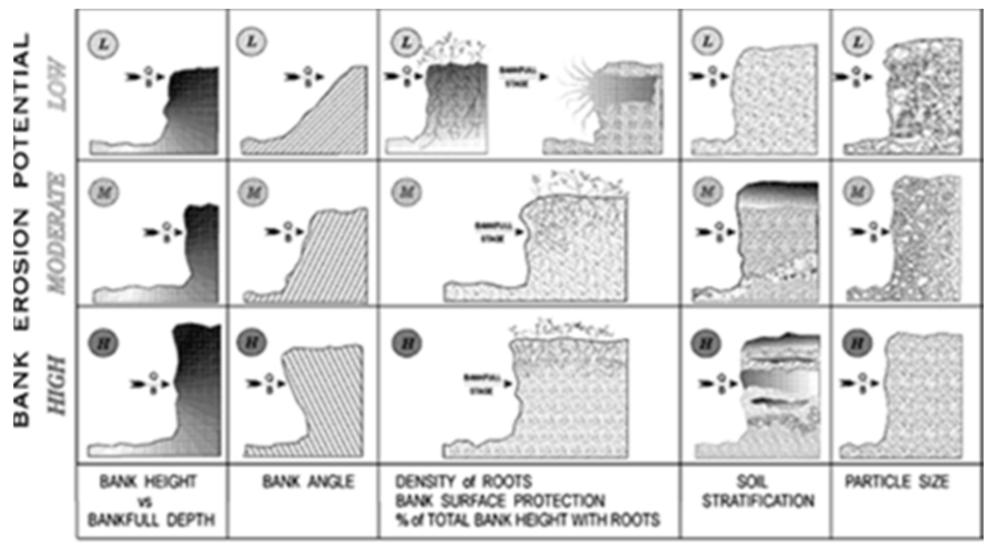
- Estimate stream sediment erosion rates
- Convert erosion rates to nitrogen and phosphorus loadings
- Estimate reduction efficiency attributed to restoration

Recommended Methods

- Monitoring
  - Surveyed cross sections, bank pins…
- BANCS method
  - With validation
- Alternative modeling approach
  - Or other methods with validation (e.g., CONCEPTS, BSTEM, stepwise regression)

Protocol 1: Credit for Prevented Sediment during Storm Flow

Step1. *Estimate Stream Sediment Erosion Rates Using the BANCS Method*



Streambank Characteristics used to develop BEHI

Velocity Gradient and Near-Bank Stress Indices

Bank Erosion Risk Rating	Velocity gradient	Near-bank stress/shear stress
Very low	Less than 0.5	Less than 0.8
Low	0.5 -1.0	0.8 -1.05
Moderate	1.1 -1.6	1.06 -1.14
High	1.61 - 2.0	1.15 - 1.19
Very High	2.1 -2.4	1.20 -1.60
Extreme	Greater than 2.4	Greater than 1.60

Protocol 1: Credit for Prevented Sediment during Storm Flow

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

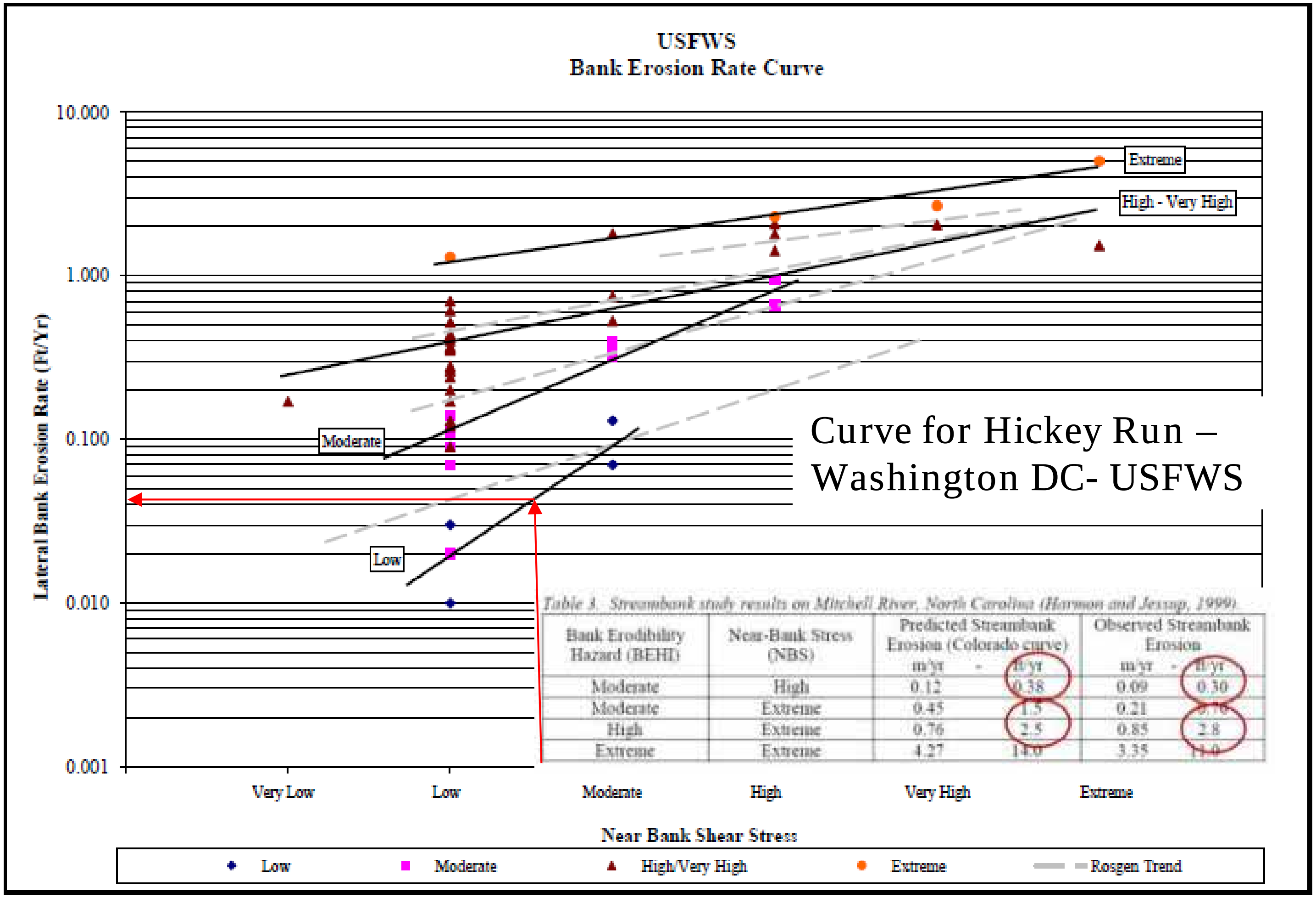


Table 3. Streambank study results on Mitchell River, North Carolina (Harmon and Jessup, 1999)

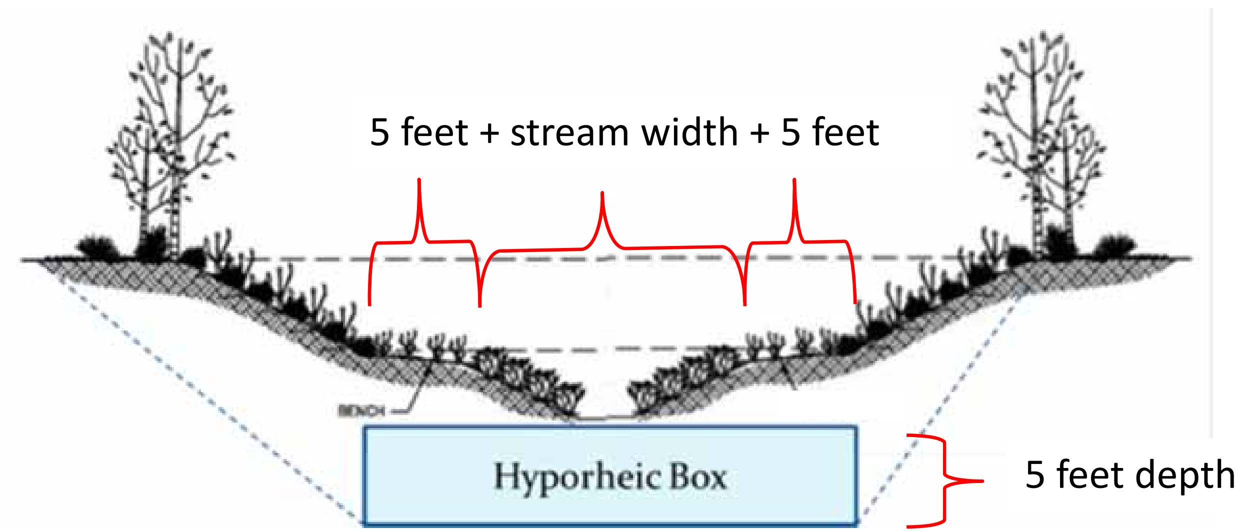
Bank Erodibility Hazard (BEHI)	Near-Bank Stress (NBS)	Predicted Streambank Erosion (Colorado curve)		Observed Streambank Erosion	
		m/yr	ft/yr	m/yr	ft/yr
Moderate	High	0.12	0.38	0.09	0.30
Moderate	Extreme	0.45	1.5	0.21	0.70
High	Extreme	0.76	2.5	0.85	2.8
Extreme	Extreme	4.27	14.0	3.35	11.0

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

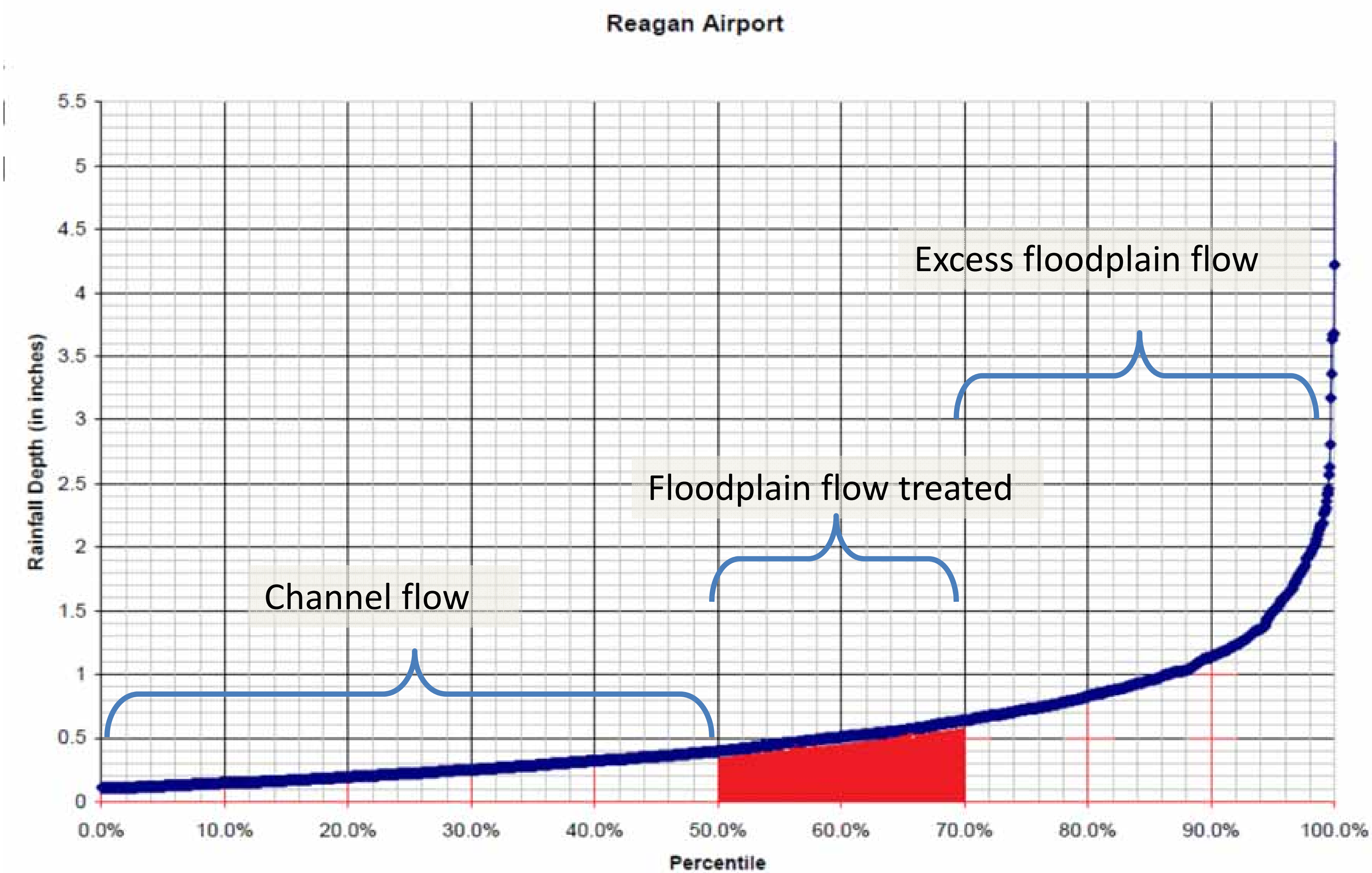
Step 1. *Determine the total post construction stream length that has been reconnected using the bank height ratio of 1.0 or less (for NCD) or the 1.0 inch storm (other design approaches that do not use the bank full storm)*

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

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

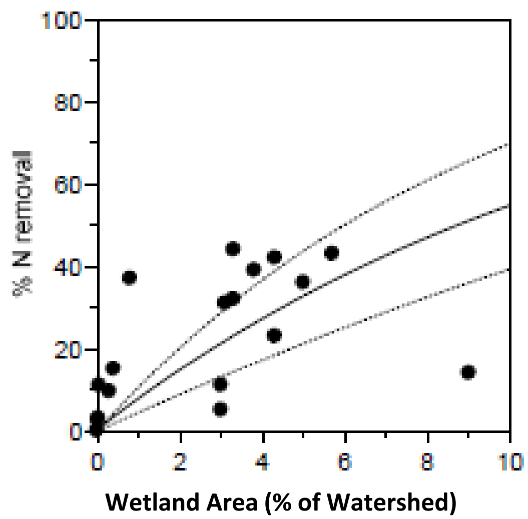


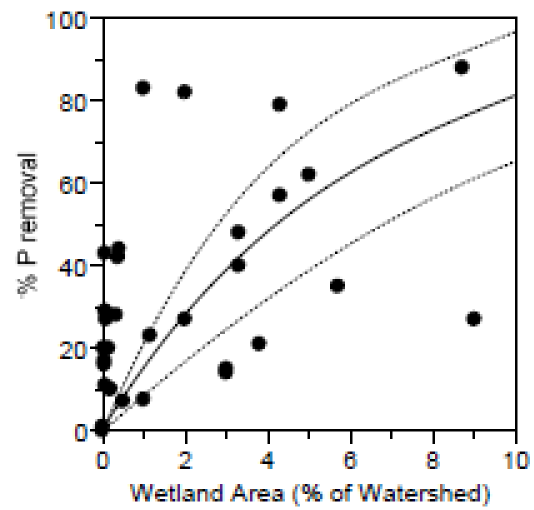
Protocol 3: Credit for Floodplain Reconnection



Basis for Protocol 3 Curves

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



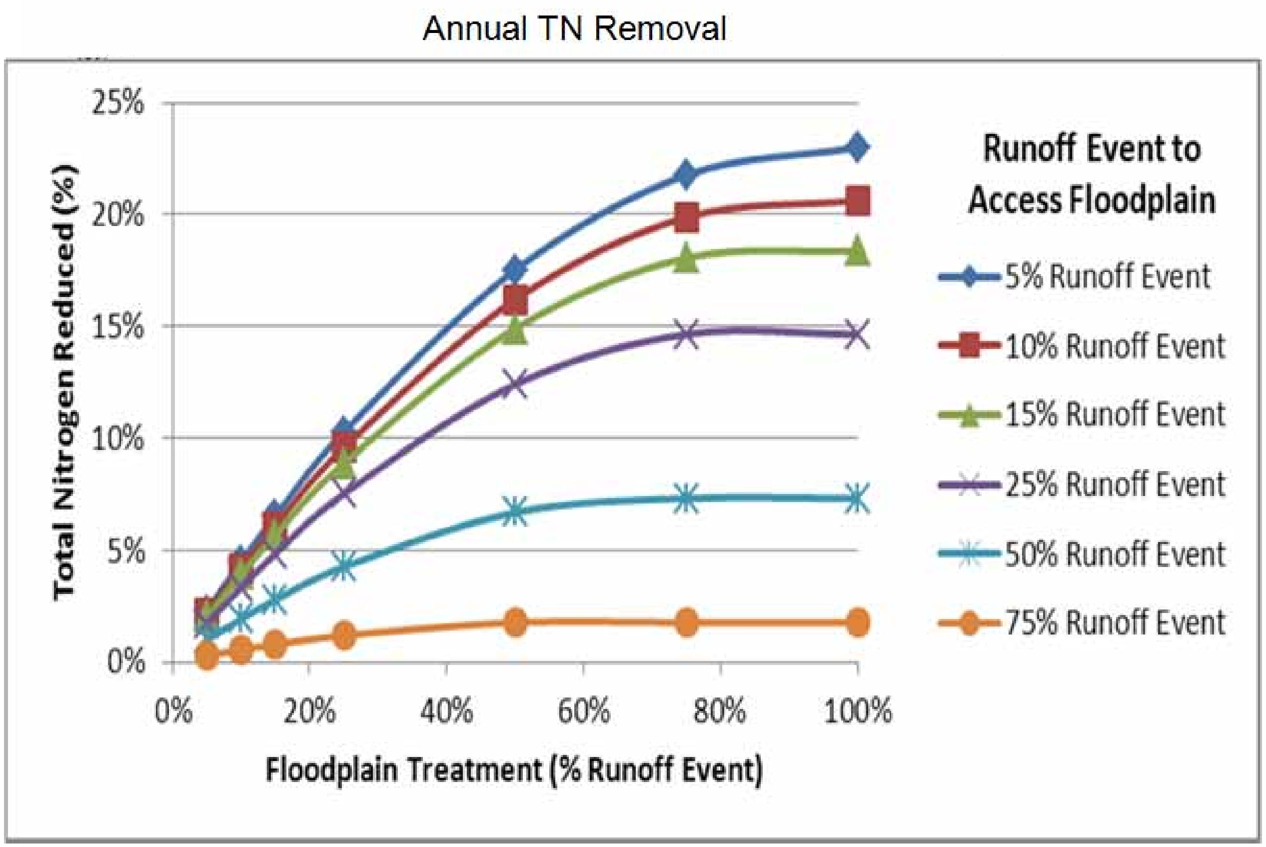


Study by Jordan, Smithsonian Environmental Research Center, as published in Weammert and Simpson, 2009. The proportion of TN and TP removed increases with the proportion of wetland area, but the rate of increase declines as the proportion of wetland area increases. Thus, the additional benefit of adding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

Protocol 3: Credit for Floodplain Reconnection Volumes

Step 1. *Estimate the floodplain connection volume*

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



Qualifying Conditions

- Stream restoration projects that are primarily designed to protect public infrastructure by bank armoring or rip rap **do not** qualify for a credit.
- The urban stream reach must be greater than 100 feet in length
- The project must utilize a comprehensive approach to stream restoration design, involving the channel and banks.
- Stream restoration project must provide a net watershed removal benefit in order to be eligible for either a sediment or nutrient credit.
- No removal credit will be granted for any project that is built to offset, compensate, or otherwise mitigate for an impact to a stream or waterway elsewhere in the watershed

Environmental Concerns

- Each project must comply with all state and federal permitting requirements.
- Stream restoration should not be implemented for the sole purpose of nutrient or sediment reduction.
- A qualifying project must meet certain presumptive criteria to ensure that high-functioning portions of the urban stream corridor are not used for in-stream stormwater treatment (i.e., where existing stream quality is still good).
- Stream restoration should be directed to areas of more severe stream impairment, and the use and design of a proposed project should also consider the level of degradation, the restoration needs of the stream, and the potential functional uplift.
- Before credits are granted, stream restoration projects will need to meet post-construction monitoring requirements, document successful vegetative establishment, and conduct initial project maintenance.
- A qualifying project must demonstrate that it will maintain or expand riparian vegetation in the stream corridor, and compensate for any project-related tree losses in project work areas.
- All qualifying projects must have a designated authority responsible for development of a project maintenance program that includes routine and long-term maintenance.

Initial Verification of Performance

- Prior to submitting the load reduction to the state tracking database, the installing agency will need to provide a post-construction certification that the stream restoration project:
  - was installed properly,
  - meets or exceeds its functional restoration objectives
  - hydraulically and vegetatively stable,
- Initial verification is provided either by the designer, local inspector or state permit authority

Verification of Stream Restoration Credit

- Max duration for the removal credits is 5 years
- Credit is renewed based on a field performance inspection that verifies the project still exists, is adequately maintained and operating as designed.
- Credit is lost if project cannot be verified (i.e., does not pass inspection).
- This creates strong incentive for localities to monitor the long term performance of their projects

The "Test-Drive" Process

- Recommended protocols are new, somewhat complex and will require project-based interpretation on the part of practitioners and regulators alike.

- Five consulting firms and one local government applied the protocols to ten different projects over the 6-month test drive period.

Main Concerns Identified during the "Test-Drive" Process

- **General Concerns**
  - The protocols are too complicated and difficult to use for planning purposes.
  - The interim rate leads to load reductions that can exceed watershed loading rates and may preclude the use of more robust protocols.
- **Protocol 1 Concerns**
  - The BANCS method may not be accurate and regional curves have not been developed.
  - The 50% efficiency requirement is too low.
  - Confusion over application of the sediment delivery factor.
- **Protocol 2 Concerns**
  - Certain types of projects result in load reductions that can exceed watershed loading especially for Protocol 2.
- **Protocol 3 Concerns**
  - The curves used to develop Protocol 3 are not accurate enough for design purposes.
  - The pre-restoration condition was not accounted for.
  - Confusion over how upstream BMPs will affect load to the project and subsequently the credit received.
  - Confusion over why the baseflow TN credit from Protocol 2 is not added to the credit from Protocol 3.

General Protocol Revisions

Concern: The protocols are too complicated and difficult to use for planning purposes.

Solution: Made it clear in the report that the interim rate is used for planning purposes and projects that do not conform to recommended reporting requirements.

General Protocol Revisions

Concern: The interim rate leads to load reductions that can exceed watershed loading rates. The interim rate may also preclude the use of more robust protocols.

Solution: The interim rate was adjusted to account for application of reduction efficiencies to TN and TSS.

Justification: An analysis of the Baltimore City data upon which the interim rate was based, revealed that a 50% efficiency was applied to TP, but not for TN and TSS.

Protocol 1 Revisions

Concern: The BANCS method may not be accurate and regional curves have not been developed.

Solution: Clarified that states are encouraged to develop their own more robust methods for estimating streambank erosion rates.

Concern: Confusion over application of the sediment delivery factor (SDF).

Solution: Added in a better description of the SDF, how the average SDF can be applied for planning purposes, and that the loads should be reported without the SDF applied because that is done in Scenario Builder.

Protocol 1 Revisions

Concern: The 50% restoration efficiency may be too low and is based on only one study.

Solution: Allowed greater than 50% restoration efficiency for projects that include monitoring to demonstrate higher rates such as Big Spring Run.

Justification: A greater incentive for monitoring will be created to achieve higher restoration efficiencies. This change will benefit projects, such as Big Spring Run, which showed greater than 70% sediment reduction.

Protocol 2 Revisions

Concern: Load reductions from Protocol 2 can be high and in some cases exceed watershed loading rates.

Solutions:

- Added a qualifying condition that TN load reduced cannot exceed 40% of the total watershed TN load.
- Original denitrification rate (1.95×10^{-4} lbs N/ton/day of soil) was an average of the low bank restoration sites in Minebank Run. Revised the rate so it is an average of both the high and low bank restoration sites (0.96×10^{-4} lbs N/ton/day of soil).

Justification: Klocker (2009) found that 40% of the daily load of nitrate in Minebank Run could be removed. In addition, the lower denitrification rate would provide a more conservative estimate to account for the variability in measured denitrification rates.

Protocol 3 Revisions

Concern: The curves used to develop Protocol 3 are not accurate enough for design purposes.

Solution: Included a better description of how the curves were developed and how other methods can be used, such as an alternate method presented in Appendix G that uses the Soil Conservation Service Runoff Curve Number.

Concern: The pre-restoration condition was not accounted for in the Protocol.

Solution: Included pre-restoration assessment and qualifying conditions.

Protocol 3 Revisions

Concern: Confusion over how upstream BMPs affect load to the project and subsequently the credit received.

Solution: The CBP Modeling Team will provide further explanation in Appendix F, which addresses modeling concerns related to Scenario Builder.

Protocol 3 Revisions

Concern: Confusion over why the baseflow TN credit from Protocol 2 is not added to the credit from Protocol 3.

Solution: Added an explanation of why Protocol 3 accounts for baseflow and stormflow (i.e., pervious and impervious loading to the project). Protocols 2 and 3 are also be allowed to be additive.

Justification: After a review of Protocol 3, it was found that the baseflow load reduction was not adequately represented.

Next Steps

- Appendix F to be completed this winter that addresses modeling concerns.
- User Training?

Questions?