Protocols for Crediting Sediment and Nutrient Load Reductions from Stream Restoration

2018 National Nonpoint Source Training Workshop

Bill Stack and Lisa-Fraley McNeal
Bay Program Expert Panels
Protocols for crediting stream restoration

Controversies about fixing the watershed before fixing the stream and different design approaches
Streambank erosion is a major source of sediment and biological impairment.

Figure 3. Sediment sources in small watersheds in the Chesapeake Bay watershed in which U.S. Geological Survey sediment fingerprinting studies were conducted or are ongoing (modified from Gellis and Walling, 2011; Devereux and others, 2010; Gellis and others, 2009).
Review of the Old and New Default Rates

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

<table>
<thead>
<tr>
<th>Source</th>
<th>TN</th>
<th>TP</th>
<th>TSS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial CBP rate based on Spring Branch</td>
<td>0.02</td>
<td>0.0035</td>
<td>2.55</td>
</tr>
<tr>
<td>Revised Default Rate</td>
<td>0.075</td>
<td>0.068</td>
<td>44.88 non-coastal plain, 15.13 coastal plain</td>
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</tbody>
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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. Additional information about the sediment delivery ratio is provided in Section 2.5 and Appendix B.

Bay modeling team added transport and delivery factors to the crediting protocols.
What is Stream Restoration?

Refers to any Natural Channel Design, Regenerative Stormwater Conveyance, Legacy Sediment Removal or other restoration project that meets the qualifying conditions for credits.

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
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)
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.

- 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

- **Step 1** – Estimate erosion rate from monitoring or modeling (e.g., BANC’s). Adjust for measured bulk density

- **Step 2** – Measure nutrient conc. or use default concentrations

- **Step 3** – Multiply erosion rate times nutrient conc.

- **Step 4** – Multiply times % 50 efficiency factor and adjust for sediment delivery factor

Monitoring data can increase this percentage
Protocol 2: Credit for Denitrification in the Hyporheic Zone during Base Flow

This protocol provides an annual mass nitrogen reduction credit for qualifying projects using empirical measurements of denitrification during base flow within a stream's hyporheic zone (stream, riparian and floodplain).

Functional ecomorphology: Feedbacks between form and function in fluvial landscape ecosystems. Stuart G. Fisher, James B. Heffernan, Ryan A. Sponseller, Jill R. Welter
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 (1.06 lbs/day/ton)

Qualifying Condition: Nitrogen removal credit cannot exceed 40% of the total nitrate load for any given land-river segment.
Protocol 3: Credit for Floodplain Reconnection

Annual mass nutrient reduction credit for projects that reconnect stream channels to their floodplain over a wide range of storm events. Floodplain reconnection projects also get credit for Protocol 1 and have less risk of failure compared to structural controls.

Floodplain Reconnection Through Legacy Sediment Removal

Big Spring Run
Lancaster PA

Photos courtesy of Jeff Hartranft, PADEP
Protocol 3: Credit for Floodplain Reconnection
Protocol 3: Credit for Floodplain Reconnection

**Step 1** – Determine the stage vs. runoff storage in the floodplain up to 1.0 ft. (floodplain connection volume)

**Step 3** – Determine the return interval of rainfall that enters the flood plain

**Step 4** – Use the treatment efficiency curves to estimate the % of annual load treated

**Step 5** – Multiply the percent of annual load treated times the average modeled upstream loading rate

Adjust if ratio of floodplain treatment area to watershed area is less than 1%
“One-Stop-Shop” for answering questions about the crediting of Stream Restoration BMPs under the Chesapeake Bay TMDL framework.

https://www.chesapeakebay.net/channel_files/24811/attach_b1_stream_restoration_faq_final_draft.pdf
Protocol Modifications: The USWG has formed five groups to tackle outstanding issues involved with stream restoration

- **Group 1:** Verifying Stream Restoration Practices
- **Group 2:** Crediting Outfall Stabilization Practices
- **Group 3:** Establishing Standards for Applying Protocol 1 (Prevented Sediment)
- **Group 4:** Adjusting Protocol 2&3 to Capture Floodplain/Stream Reconnection
Other adaptations of the Protocols
Crediting Water Quality Benefits from Stream Restoration: Implementation Case Studies and Potential for Crediting Guidance Application

WRF Project Number: SIWM-17-17

Goal: To highlight state and municipal experience with the stream crediting protocols inside and outside of the Chesapeake Bay watershed.

- Summary of monitoring studies and stream restoration crediting and trading programs in the Chesapeake Bay watershed
- Literature review of strategies for restoring streams through the control of watershed processes and channel reconfiguration
- Summary of state and municipal survey results
Monitoring Studies

15 studies in MD, PA, VA, DC.

Study results can be used to:

- Compare measured bank erosion sediment loads to BANCS
- Evaluate the use of alternative monitoring approaches (lidar, photogrammetry)
- Show how site-specific values of bulk density and TN/TP soil concentrations affect calculated load reductions
State and Municipal Surveys

- Conducted March - April 2018
- 37 Chesapeake Bay Watershed Respondents
- 41 Outside of the Chesapeake Bay Watershed Respondents
State and Municipal Surveys

Distribution of MS4s/Non-MS4s **within** the Chesapeake Bay Watershed

- 38% Phase I MS4
- 32% Phase II MS4
- 22% Not an MS4
- 8% Other

Distribution of MS4s/Non-MS4s **outside** the Chesapeake Bay Watershed

- 37% Phase I MS4
- 27% Phase II MS4
- 19% Not an MS4
- 17% Other
State and Municipal Surveys
Use of the Stream Restoration Protocols

Chesapeake Bay Watershed
Mostly used to calculate water quality benefits from stream restoration projects driven by permit requirements and the Chesapeake Bay TMDL.

Outside the Chesapeake Bay Watershed
Water quality benefits of stream restoration projects not calculated.
Chesapeake Bay Watershed

1/3 of MS4 respondents don’t use the stream restoration protocols due to:

- TMDLs that focus on pollutants other than nutrients and sediments
- Confusion over how to apply the protocols
- Protocols are too complicated

Outside the Chesapeake Bay Watershed

- Unsure of the methodology
- Focus other than water quality benefits
- Lack of regulatory drivers
- Want state acknowledgement of the guidance first before committing to using it.
More than half of all survey respondents (both inside and outside the Chesapeake Bay watershed) indicated a training workshop would be the most beneficial to help them use the protocols.

20% of MS4s in the Chesapeake Bay watershed indicated that a list of consultants with demonstrated knowledge of the protocols would be useful.

Other suggestions included:

- Concrete case studies showing the application of the protocols in various circumstances
- Low-cost online training course
- Examples and workbooks based on the guidance
- Manual for self-learning
- Outreach to municipalities about the protocols
Next Steps

Project report is currently under review by the WRF Project Advisory Committee.

Once complete the final report will be available through WRF:

Questions?