# Cost/Benefit Analysis of Stream Restoration as a Nutrient and Sediment Offset

An examination of the monetary
impacts that occurs within a
range of variables associated with
nutrient reduction estimates from
TMDL based stream projects
in Maryland and Virginia

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February 17, 2017

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# Presentation Outline

1 Brief Introduction

2 Background on the use of SR as a Nutrient Offset

3 Costs associated with SR (Case Studies)

4 Conclusions/Discussions/Questions

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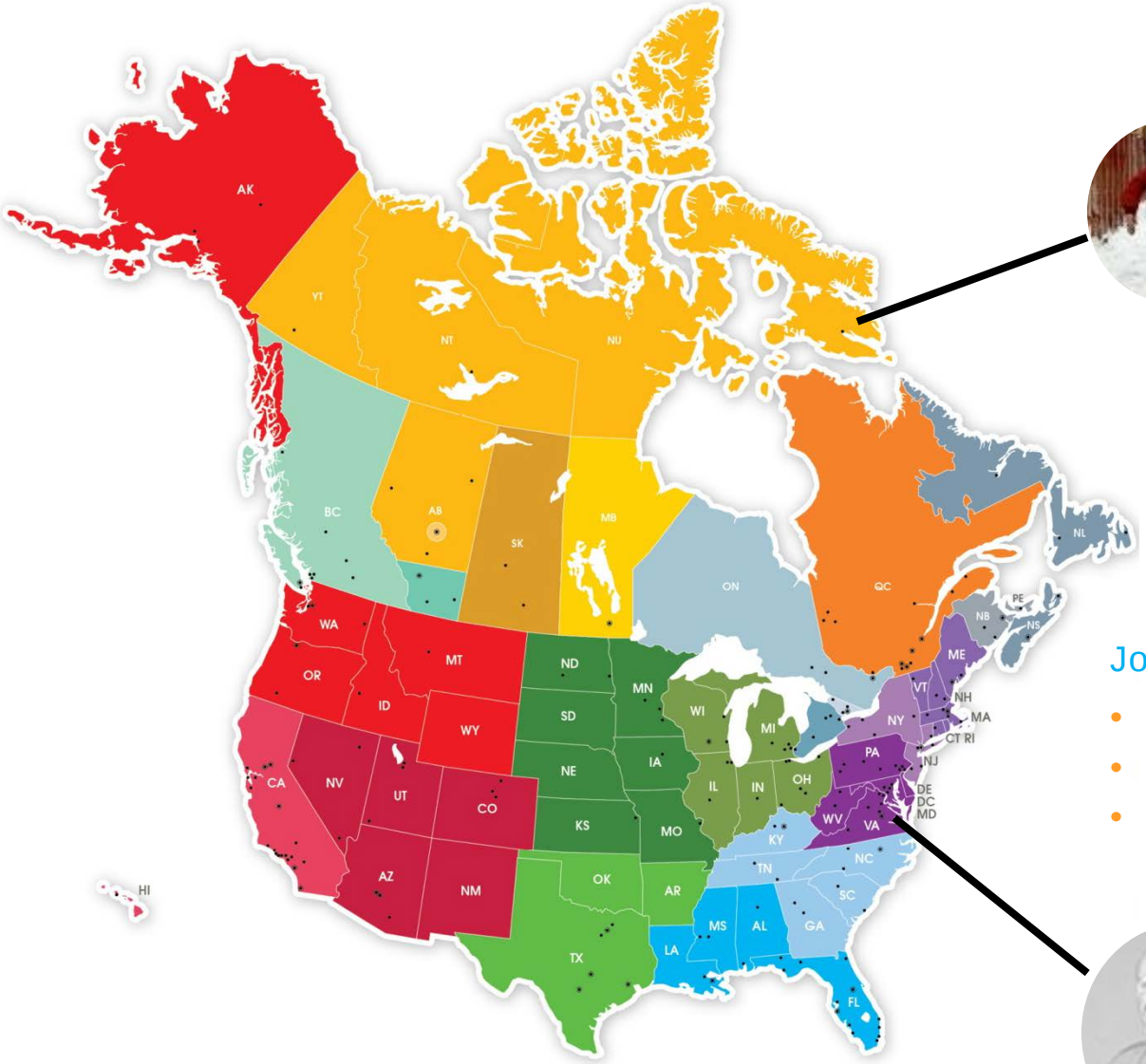


Josh Running

- *Sr Environmental Planner/Associate*
- Williamsburg, VA
- 17 years experience

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# 2 Stream Restoration as a Nutrient Reduction Offset

Note: The purpose of this presentation is focused on costs and the application of stream restoration as a nutrient reduction offset. However, it is recognized that there are many other benefits to a stable stream and that doing restoration purely for the nutrient benefit is not the intention of CBPO or its partners.

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# Quick Ches-BAY Download

## The Chesapeake Bay

- **1983**: CB Agreement leading to formation of CB Program Office and CB Executive Council
- **1987 & 2000**: CB Landmark Agreements
- **2009**: E. O. declaring CB a National Treasure
- **2010**: CB TMDL established; 6 Bay States and DC begin WIP development to achieve 2025 goals
- **2013**: Regulatory changes in Virginia alter way MS4 localities & agencies plan and develop in the Bay
- **2018 & 2023**: Incremental Numeric Reduction Target dates for VA MS4s ~1.25% & ~8.75%)
- **2025 Target Date**: Reduction of Pollution Levels **by 20-25%** over 2009 levels*


**Cost estimated at $7-10 Billion.*

*Costs are for SWM only (Total = $13.6-15.7B if include Ag, WW) and are attributed to Local Governments and State Agency in Virginia. Costs (source: VA Senate Finance Committee).*

*Largest Polluter in the Chesapeake is Sediment. Also Carries with it other Macro Nutrients (N &P)*

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# The Role of Stream Restoration

- Degraded and Eroding Urban streams are and can be a significant source of sediments and nutrients. Some estimates have found:

  *"almost ¾ of the sediment…in streams…comes from channel and bank erosion with only about ¼…coming from upland soil erosion"*. (Osmond et al. 2012 summarizing several watershed studies)

Some Debate Here

- Stream restoration is very cost effective solution ($/lb basis compared to traditional SWM)

- CBPO estimates that 418 miles of Urban Stream Restoration will be implemented in VA and MD alone by 2025*

**(NOTE: estimates include historical projects and is derived from Phase 2 WIP submissions to EPA in 2012 and summarized by Jeff Sweeney of EPA CBPO.)*

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# CBPO Stream Restoration Expert Panel Report

*WEG (Stantec) invited to "test drive" Report*

*~ May 2013 – Oct 2013*

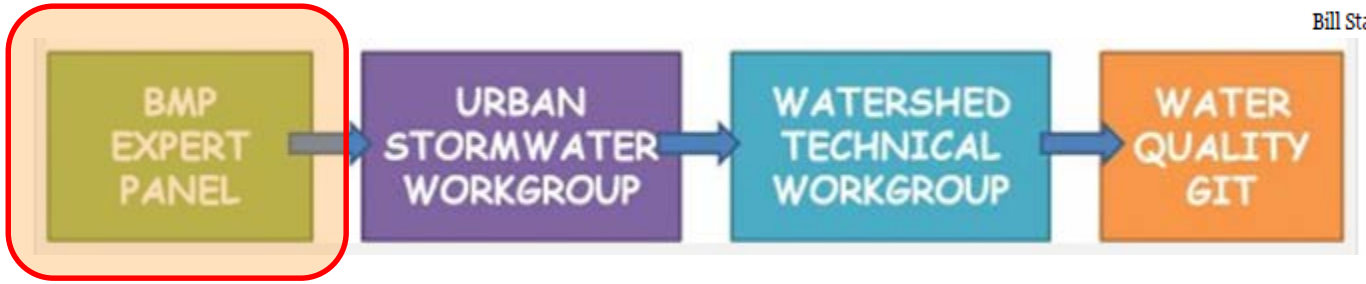
Developed to outline methods to quantify sediment and nutrient reductions from individual projects in an effort to "credit" projects to help offset reduction requirements

Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Joe Berg, Josh Burch, Deb Cappuccitti, Solange Filoso, Lisa Fraley-McNeal, Dave Goerman, Natalie Hardman, Sujay Kaushal, Dan Medina, Matt Meyers, Bob Kerr, Steve Stewart, Bettina Sullivan, Robert Walter and Julie Winters

Accepted by Urban Stormwater Work Group (USWG): **February 19, 2013**
Approved by Watershed Technical Work Group (WTWG): **April 5, 2013**
Final Approval by Water Quality Goal Implementation Team (WQGIT): **May 13, 2013**
Test-Drive Revisions Approved by the USWG: **January 17, 2014**
**Test-Drive Revisions Approved by the WTWG: August 28, 2014**
**Test-Drive Revisions Approved by the WQGIT: September 8, 2014**

Prepared by:
Tom Schueler, Chesapeake Stormwater Network
and
Bill Stack, Center for Watershed Protection

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# CBPO Stream Restoration Expert Panel Report

Methods to Quantify Reductions:

- Default Removal Rate
  - Fixed rate of TN, TP, TSS reductions per L.F. of stream restoration (ex: 0.068 lbs/LF/yr x 1,000 LF = 68 lbs TP/yr)

| Table 3. Edge-of-Stream 2011 Interim Approved Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr) | | | |
|---|---|---|---|
| **Source** | **TN** | **TP** | **TSS*** |
| **Revised Default Rate** | **0.075** | **0.068** | **44.88** non-coastal plain<br>**15.13** coastal plain |

**OR**

- Application of 4 Protocols from Expert Panel Report…they are:

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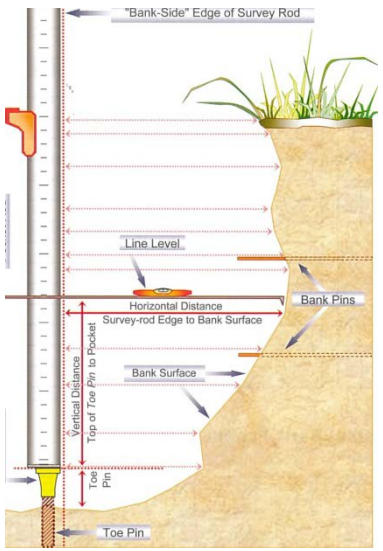
# CBPO SR Expert Panel Report: 4 Protocols

- **P1**- Credit for Prevented Sediment During Storm Flow




- **P2**- Credit for Instream & Riparian Nutrient Processing within the Hyporheic Zone During Base Flow

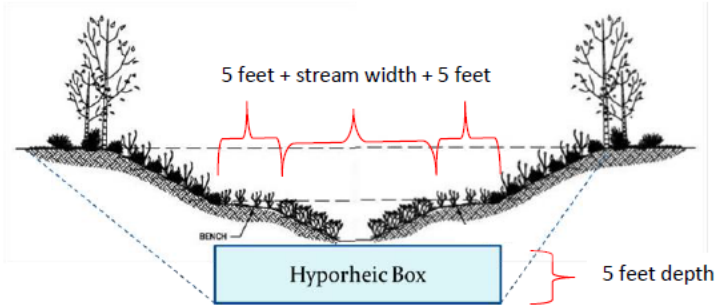
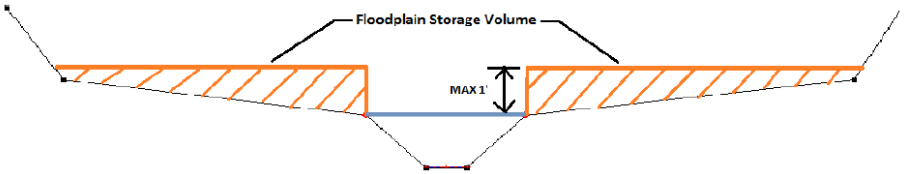
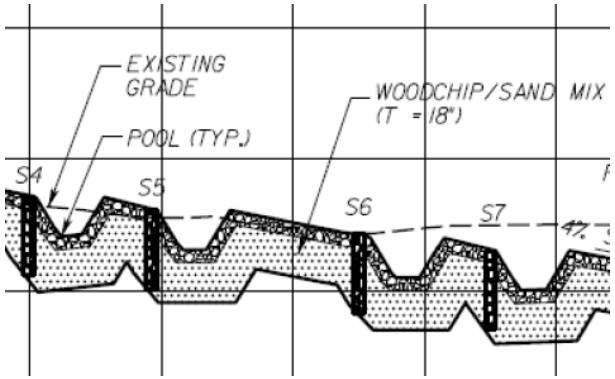



**Figure 2. Hyporheic box that extends the length of the restored reach**

- **P3**- Credit for Floodplain Reconnection Volume




- **P4**- Dry Channel RSC as an Upland Stormwater **Retrofit**

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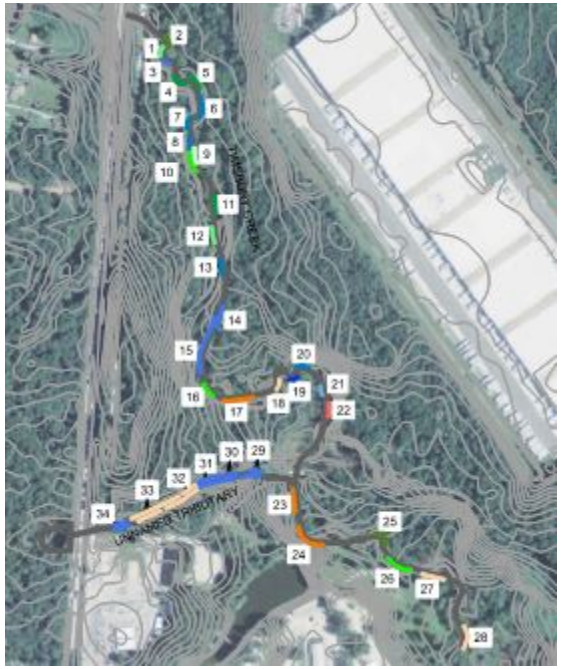
# Focus on Protocol 1 (BANCS)



**Worksheet 3-13.** Summary form of annual streambank erosion estimates for various study reaches.

| Stream: | Site 1: Timsbury Creek and Tributary | | | | Location: Richmond, VA | | |
|---|---|---|---|---|---|---|---|
| Graph Used: | NC | Total Stream Length (ft): 5650 | | | | | Date: 1/29/2016 |
| Observers: | JR | | Valley Type: | | | | Stream Type: |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Station (ft) | BEHI rating (Worksheet 3-11) (adjective) | NBS rating (Worksheet 3-12) (adjective) | Bank erosion rate (Figure 3-9 or 3-10) (ft/yr) | Length of bank (ft) | Study bank height (ft) | Erosion subtotal [(4)×(5)×(6)] ($ft^3$/yr) | Erosion Rate (tons/yr/ft) ([(7)/27] × 1.69 / (5)) |
| 22 Bank 22 | Very High | Moderate | 0.730 | 71.0 | 8.0 | 414.64 | 0.36554 |
| 23 Bank 23 | High | High | 0.200 | 114.0 | 5.0 | 114.00 | 0.06259 |
| 24 Bank 24 | High | High | 0.200 | 163.0 | 12.0 | 391.20 | 0.15022 |
| 25 Bank 25 | Low | Very High | 0.140 | 106.0 | 4.0 | 59.36 | 0.03505 |
| 26 Bank 26 | Low | Moderate | 0.027 | 130.0 | 4.0 | 14.25 | 0.00686 |
| 27 Bank 27 | High | Moderate | 0.160 | 113.0 | 6.0 | 108.48 | 0.06009 |
| 28 Bank 28 | High | Moderate | 0.160 | 119.0 | 4.0 | 76.16 | 0.04006 |
| 29 Bank 29 | Moderate | Moderate | 0.060 | 155.0 | 2.0 | 18.60 | 0.00751 |
| 30 Bank 30 | Low | Moderate | 0.027 | 147.0 | 1.4 | 5.56 | 0.00237 |
| 31 Bank 31 | Moderate | Moderate | 0.060 | 192.0 | 0.9 | 10.37 | 0.00338 |
| 32 Bank 32 | High | Moderate | 0.160 | 268.0 | 1.9 | 81.47 | 0.01903 |
| 33 Bank 33 | High | Moderate | 0.160 | 370.0 | 4.0 | 236.80 | 0.04006 |
| 34 Bank 34 | Moderate | Moderate | 0.060 | 136.0 | 2.5 | 20.40 | 0.00939 |
| | | | | | | | |
| | | | | | | | |
| mn (7) for each BEHI/NBS combination | | | | | Total Erosion ($ft^3$/yr) | 4506.52 | |
| $^3$/yr (divide Total Erosion ($ft^3$/yr) by 27) | | | | | Total Erosion ($yds^3$/yr) | 166.91 | |
| ons/yr (multiply Total Erosion ($yds^3$/yr) | | | | | Total Erosion (tons/yr) | 282.07 | |
| gth of channel (divide Total Erosion sm (ft) surveyed) | | | | | Unit Erosion Rate (tons/yr/ft) | 0.0499 | |

ology

*River Stability Field Guide* page 3-89

**Table 9. Summary of Potential Nutrient Reduction Rates for Three (3) Stream Restoration Projects**

| No. | Restoration Project Name | Length (L.F.) | TP Load Reduction (lbs/yr) | TP Unit Load Reduction on per L.F. basis (lbs/L.F./yr) |
|---|---|---|---|---|
| 1 | Timsbury Creek (Upper, Middle, TRIB) | 2,638 | 263 | 0.097 |
| 2 | Proctor's Creek (Upper) | 1,500 | 46 | 0.031 |
| 3 | Skiffes Creek | 477 | 117 | 0.262 |
| | | | | |
| **All** | **Total for all 3 Projects** | **4,615** | **426** | **0.092** |

Using BANCS and Standard P Concentration

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# 3 Costs associated with Stream Restoration and Nutrient Removal

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# Costs for removal – Traditional Stormwater

**Table 2. Properties of BMPs Selected for Cost Estimation**

| BMP ID | BMP Type | 4-digit HUC | Impervious Area Treated (acres) | WQV Treated ($ft^3$) | Annual Phosphorus Removal (lb) | Removal Efficiency |
|---|---|---|---|---|---|---|
| 1 | Extended detention basin[a] | York | 2.44 | 8414.34 | 1.85 | 35% |
| 2 | Extended detention basin[a] | York | 2.56 | 8828.16 | 1.94 | 35% |
| 3 | Extended detention basin[a] | York | 8.01 | 27622.49 | 6.08 | 35% |
| 4 | Extended detention basin[b] | Potomac | 4.27 | 14725.10 | 3.24 | 35% |
| 5 | Extended detention basin[b] | Potomac | 7.33 | 25277.51 | 5.57 | 35% |
| 6 | Extended detention basin[b] | Potomac | 7.42 | 25587.87 | 5.64 | 35% |
| 7 | Extended detention basin[b] | Potomac | 15.15 | 52244.78 | 11.51 | 35% |
| 8 | Sand filter[c] | Potomac | 4.40 | 7586.70 | 6.21 | 65% |
| 9 | Extended detention enhanced basin[c] | Potomac | 9.20 | 31726.20 | 9.98 | 50% |

BMP = best management practice; HUC = hydrologic unit code; WQV = water quality volume.
[a] Functional class: rural collector rolling undivided.
[b] Functional class: rural principal arterial.
[c] Functional class: urban minor arterial.

**Table 3. Component Costs of BMPs Selected for Cost Estimation**

| BMP ID | Pre-Construction | Construction | Lifetime O&M | ROW | Total | | Per Pound of Annual Phosphorus Removal | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Including ROW | Excluding ROW | Including ROW | Excluding ROW |
| 1 | $7,487.90 | $23,399.69 | $3,481.28 | $24,081.55 | $34,368.87 | $58,450.43 | $18,545.89 | $31,540.61 |
| 2 | $15,049.60 | $47,030.01 | $6,996.88 | $35,691.84 | $69,076.49 | $104,768.33 | $35,527.32 | $53,884.30 |
| 3 | $20,083.53 | $62,761.02 | $9,337.26 | $30,077.16 | $92,181.80 | $122,258.96 | $15,152.52 | $20,096.50 |
| 4 | $15,265.14 | $47,703.55 | $7,097.08 | $35,327.13 | $70,065.77 | $105,392.89 | $21,604.80 | $32,497.93 |
| 5 | $48,580.29 | $151,813.40 | $22,586.00 | $57,992.14 | $222,979.68 | $280,971.82 | $40,052.86 | $50,469.73 |
| 6 | $46,085.87 | $144,018.34 | $21,426.29 | $62,088.79 | $211,530.50 | $273,619.28 | $37,535.42 | $48,552.88 |
| 7 | $79,023.29 | $246,947.78 | $36,739.59 | $53,814.44 | $362,710.66 | $416,525.10 | $31,522.45 | $36,199.35 |
| 8 | $29,889.55 | $93,404.84 | $166,755.37 | $49,801.21 | $290,049.76 | $339,850.97 | $46,735.48 | $54,759.91 |
| 9 | $88,069.13 | $275,216.03 | $184,253.38 | $200,549.55 | $547,538.54 | $748,088.08 | $54,852.59 | $74,943.71 |

BMP = best management practice; O&M = operation and maintenance; ROW = right of way.

Virginia Center for Transportation INNOVATION & RESEARCH

**Investigating the Cost-Effectiveness of Nutrient Credit Use As an Option for VDOT Stormwater Permitting Requirements**

http://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r9.pdf


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20-75K

**Phosphorus Credit Cost**

Fixed prices for 1-pound phosphorus credits in the James, Potomac, Rappahannock, and York watersheds were provided by VDOT's Location and Design Division. The cost of a 1-pound phosphorous credit in the James and Potomac watersheds is $10,430 and $18,700, respectively. The cost of a 1-pound phosphorous credit in the York and Rappahannock watersheds in on a sliding scale from $17,000 to $20,000 and $14,700 to $16,450, respectively. The cost of credits in the York and Rappahannock watersheds decreases as more credits are purchased. The credits are managed through a clearinghouse, which generates the credits by converting agricultural land to forest land or building urban BMPs.

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# Project A Spotsylvania County, VA (400 LF)

Phosphorous Removed – 111 LB/YR
Total Project Cost - 700K

Per Pound of P - $6,306
Value in Watershed – 1.65 Million
( 15k/LB x 111lbs)

# Project B

York County, VA

Phosphorous Removed – 141 LB/YR
Total Project Cost 1.2 Million

York County, Virginia
800 LF

Per Pound of P - $8,511
Value in Watershed – 2.4 Million
(17k LB X 141 LBS)

# Project C

Harford, MD (5288 LF)

Phosphorous Removed – 2575 LB/YR
Total Project Cost 6.6 Million +/-
Estimated – Not constructed yet

Per Pound of P - $2,563
Value in Watershed – N/A

# Nutrient Removal Cost Summary

| | |
|---|---|
| • Traditional Stormwater | $20-75K per LB P |
| • Nutrient Bank (in VA only) | $15-20K per LB P |
| • Project A* | $6,306 per LB P |
| • Project B** | $8,511 per LB P |
| • Project C*** | $2,563 per LB P |

** Construction completed. Numbers reflect actual measured bank recession and soil concertation rates. Project efficiency was 90% (not 50%).*

*** Construction completed. Number reflect actual measured soil concentration rates but utilized NC Curve. Project efficiency was 50%.*

**** Construction cost estimated. Numbers reflect actual measured soil concentrations, bulk densities and recession rates. Project efficiency was 50%.*

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# 4 Conclusions/Discussion/Questions

- The Chesapeake Bay has undertaken a massive cleanup effort, similar to the Mobile Estuarine Program goals.
- Case studies and monitoring point to the most cost effective way to reduce pollution, stream restoration.
- Clients have been able to get stretch dollars and get almost twice as many projects in the ground then when using traditional stormwater techniques.

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