Identify Cost Effective BMPs

BMPs for Improving Water Quality and Maximizing Co-Benefits

Cost effectiveness increases implementation

- Best management practices (BMPs) must be implemented to reduce nitrogen, phosphorus, and sediment loads to meet the requirements of the Chesapeake Bay Total Maximum Daily Load (Bay TMDL)
- Local TMDLs also are in place for those pollutants and for bacteria, PCBs and more
- BMPs selected for implementation may be assessed on three factors:
  - can be more or less effective in reducing total pollutants
  - have a high or low unit cost of pollutant reduction
  - have co-benefits that meet local TMDLs and priorities, or not
- Cost effectiveness is important given limited funding for environmental improvements
- Implementing a BMP to achieve multiple objectives facilitates program and funding prioritization, and may result in a greater likelihood of implementation

Methods/Overview

- Estimate cost effectiveness and co-benefits per BMP
- Compare the most implemented to the most cost-effective and the bacteria co-benefit
- Match the N or P reduced by the BMPs in 2018 by applying more cost-effective BMPs that allow a comparison of acres impacted and costs for reducing the same amount of N or the same amount of P
- Assess the marginal change in load reduction

Methods: BMP cost effectiveness

CAST is the Chesapeake Bay Program Phase 6 Watershed Model

Calculates the nitrogen, phosphorus and sediment load with a suite of BMPs

There is no output of load reduced per BMP

↓

Estimates of N, P and S reduction and cost per unit for each BMP

Devereux and Rigelman used a series of BMP "isolation" CAST scenarios to calculate the pounds of nitrogen, phosphorus and sediment reduced per each BMP

The design of the scenarios isolates the load reduced from each BMP while including the interaction effects of other BMPs, and is useful for assessing relative differences among BMPs

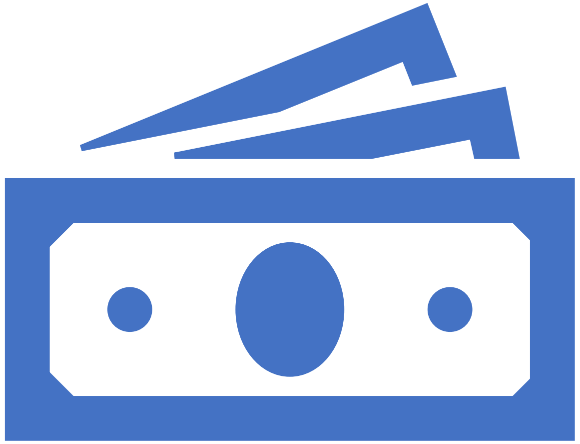
Data are available on the CAST website, some interpretation is necessary
https://public.tableau.com/profile/olivia.devereux#!/vizhome/BMPCost-Effectiveness/Nitrogen

BMP Isolation Scenario Example

- Developed Impervious Surface Reduction
- AgricultureBiofilters
- AgricultureLagoon Covers
- AgricultureTillage Management-Conservation
- Developed Erosion and Sediment Control Level 1
- Developed Mechanical Broom Technology - 1 pass/4 weeks
- Developed Nutrient Management Plan
- AgricultureWater Control Structures

Plus all other BMPs approved by CBP for planning

BMP Costs

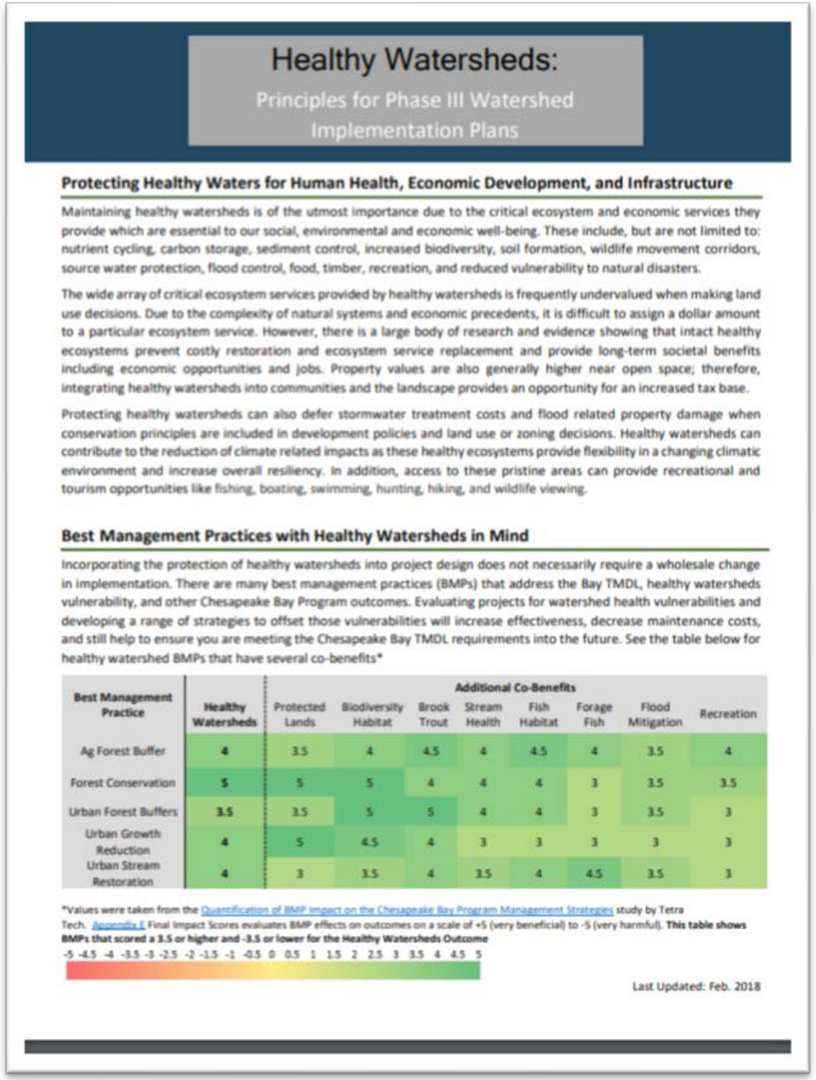


- Costs are the annual average cost
- Costs are those incurred by both public and private entities
- These unit cost per BMP support calculating the annualized cost per pound reduced per year

For each BMP per year = $\frac{\$}{pound\ reduced}$

Methods: Co-Benefits

- Co-benefits of implemented BMPs are assessed using qualitative impact scores developed for the Chesapeake Bay Program to support integrated implementation for multiple Chesapeake Bay Program Partnership management strategies
    - Scores can be used to indicate the anticipated impact of a BMP on a co-benefit
    - Information source: "Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies" Tetra Tech (2017)
- There are 28 recognized co-benefits, fact sheets are available for 12 of them
- This analysis took the BMPs that were beneficial for bacteria and compared those to the most cost effective and most implemented BMPs



Healthy Watersheds:

Principles for Phase III Watershed Implementation Plans

Protecting Healthy Waters for Human Health, Economic Development, and Infrastructure

Maintaining healthy watersheds is of the utmost importance due to the critical ecosystem and economic services they provide which are essential to our social, environmental and economic well-being. These include, but are not limited to: nutrient cycling, carbon storage, sediment control, increased biodiversity, soil formation, wildlife movement corridors, source water protection, flood control, food, timber, recreation, and reduced vulnerability to natural disasters.

The wide array of critical ecosystem services provided by healthy watersheds is frequently undervalued when making land use decisions. Due to the complexity of natural systems and economic precedents, it is difficult to assign a dollar amount to a particular ecosystem service. However, there is a large body of research and evidence showing that intact healthy ecosystems prevent costly restoration and ecosystem service replacement and provide long-term societal benefits including economic opportunities and jobs. Property values are also generally higher near open space; therefore, integrating healthy watersheds into communities and the landscape provides an opportunity for an increased tax base.

Protecting healthy watersheds can also defer stormwater treatment costs and flood related property damage when conservation principles are included in development policies and land use or zoning decisions. Healthy watersheds can contribute to the reduction of climate related impacts as these healthy ecosystems provide flexibility in a changing climatic environment and increase overall resiliency. In addition, access to these pristine areas can provide recreational and tourism opportunities like fishing, boating, swimming, hunting, hiking, and wildlife viewing.

Best Management Practices with Healthy Watersheds in Mind

Incorporating the protection of healthy watersheds into project design does not necessarily require a wholesale change in implementation. There are many best management practices (BMPs) that address the Bay TMDL, healthy watersheds vulnerability, and other Chesapeake Bay Program outcomes. Evaluating projects for watershed health vulnerabilities and developing a range of strategies to offset those vulnerabilities will increase effectiveness, decrease maintenance costs, and still help to ensure you are meeting the Chesapeake Bay TMDL requirements into the future. See the table below for healthy watershed BMPs that have several co-benefits*

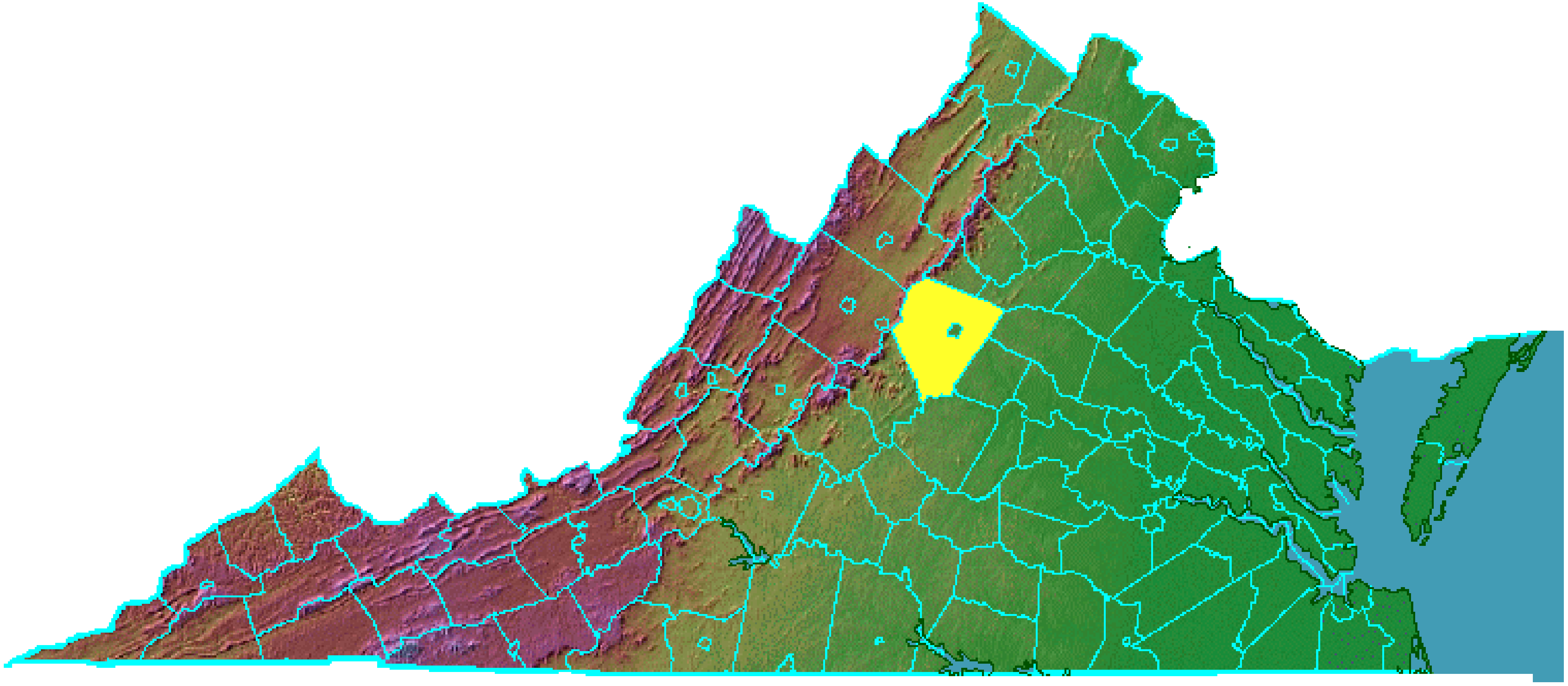
Best Management Practice	Healthy Watersheds	Additional Co-Benefits							
		Protected Lands	Biodiversity Habitat	Brook Trout	Stream Health	Fish Habitat	Forage Fish	Flood Mitigation	Recreation
Ag Forest Buffer	4	3.5	4	4.5	4	4.5	4	3.5	4
Forest Conservation	5	5	5	4	4	4	3	3.5	3.5
Urban Forest Buffers	3.5	3.5	5	5	4	4	3	3.5	3
Urban Growth Reduction	4	5	4.5	4	3	3	3	3	3
Urban Stream Restoration	4	3	3.5	4	3.5	4	4.5	3.5	3

*Values were taken from the Quantification of BMP Impact on the Chesapeake Bay Program Management Strategies study by Tetra Tech. Appendix E Final Impact Scores evaluates BMP effects on outcomes on a scale of +5 (very beneficial) to -5 (very harmful). **This table shows BMPs that scored a 3.5 or higher and -3.5 or lower for the Healthy Watersheds Outcome**

-5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

Last Updated: Feb. 2018

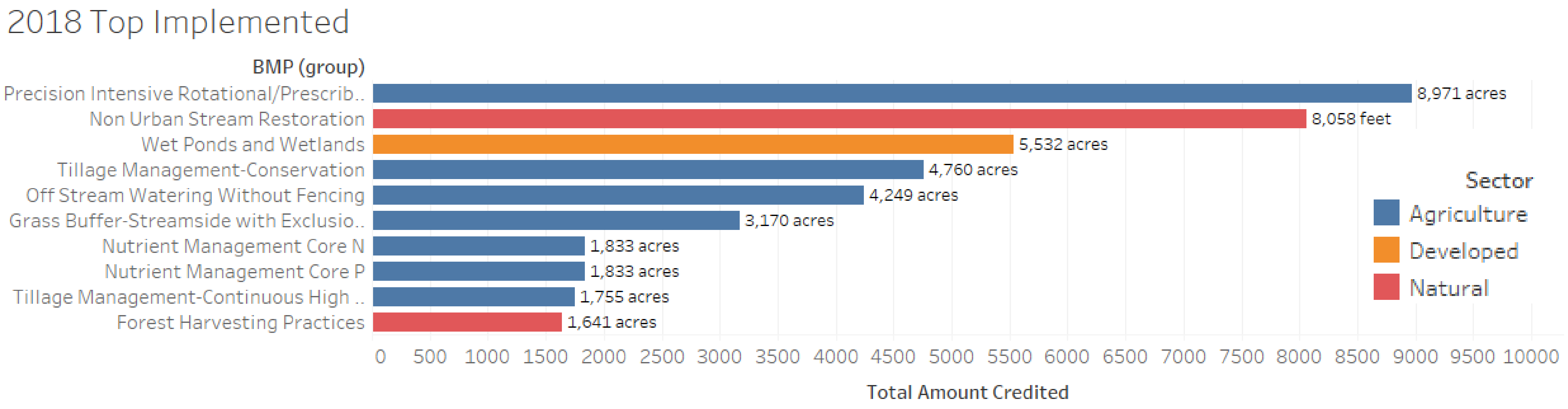
Albermarle County

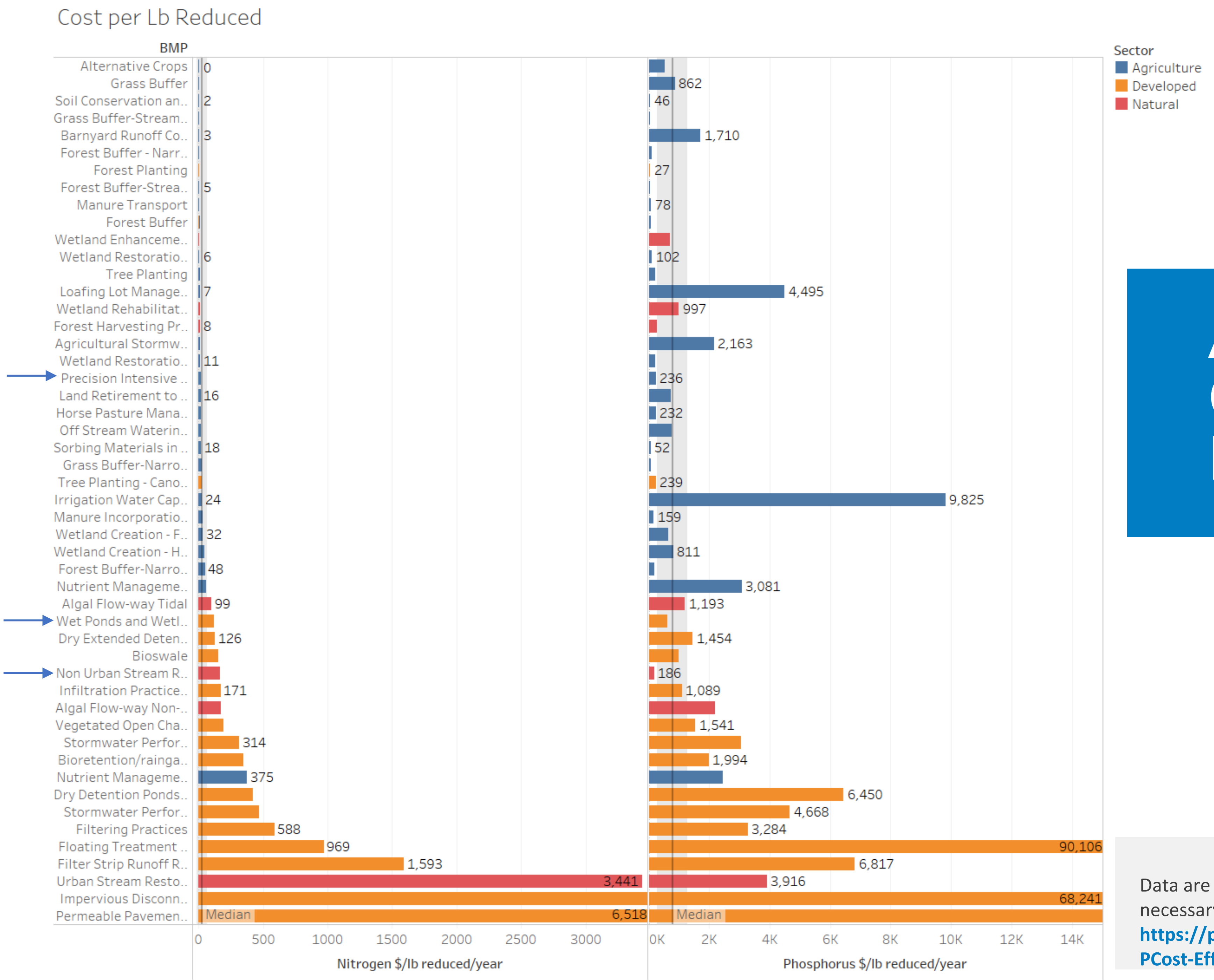


Methods Summary

- Most implemented vs. most cost effective for top 5 BMPs
- Co-Benefits associated with most cost effective
- Marginal change in loads

Albemarle: Top 10 Implemented BMPs in 2018



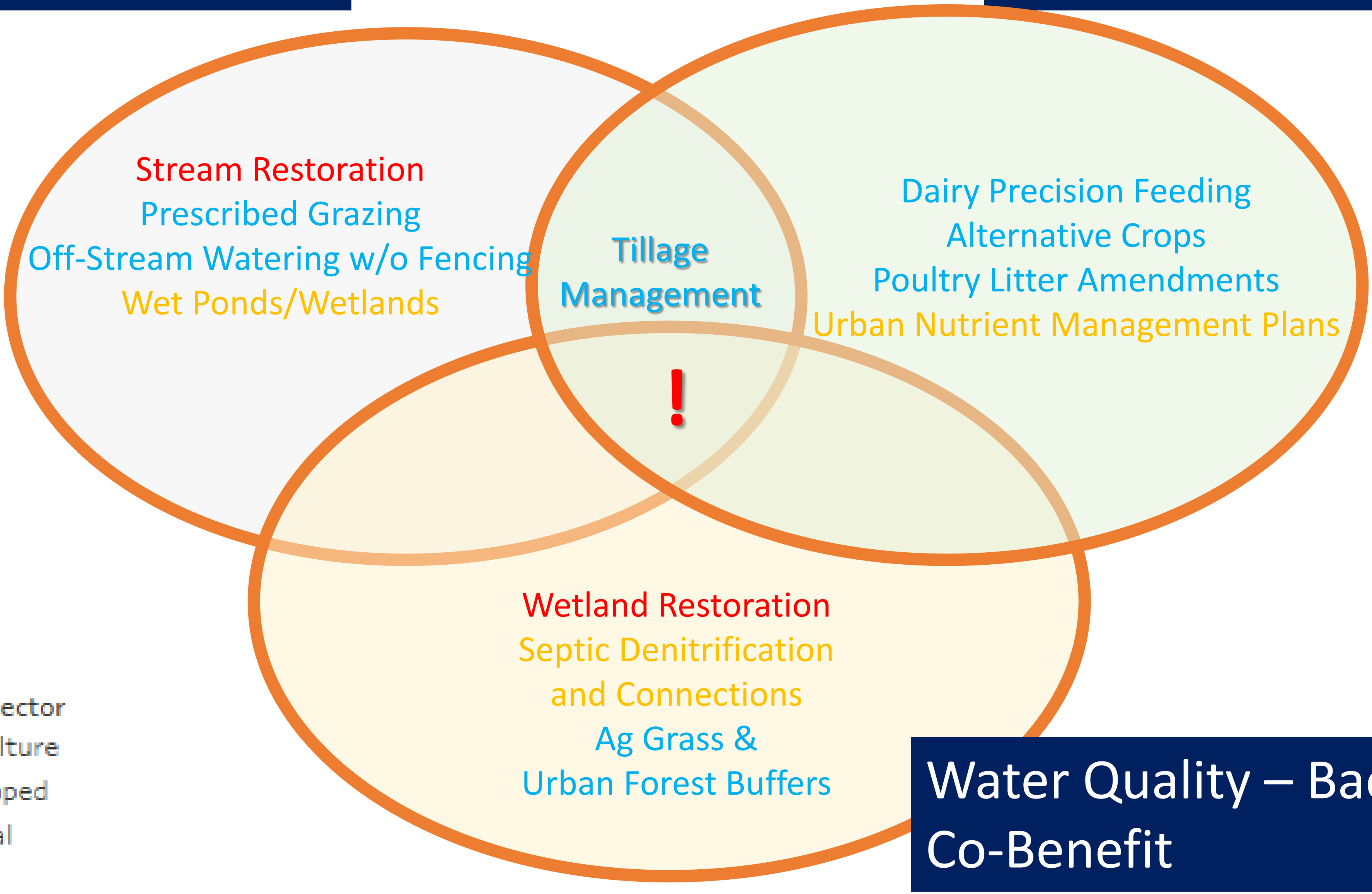


Albemarle: Cost per Lb Reduced

Data are available on the CAST website, some interpretation is necessary
https://public.tableau.com/profile/olivia.devereux#!/vizhome/BMPCost-Effectiveness/Nitrogen

Most Implemented

N Most Cost Effective

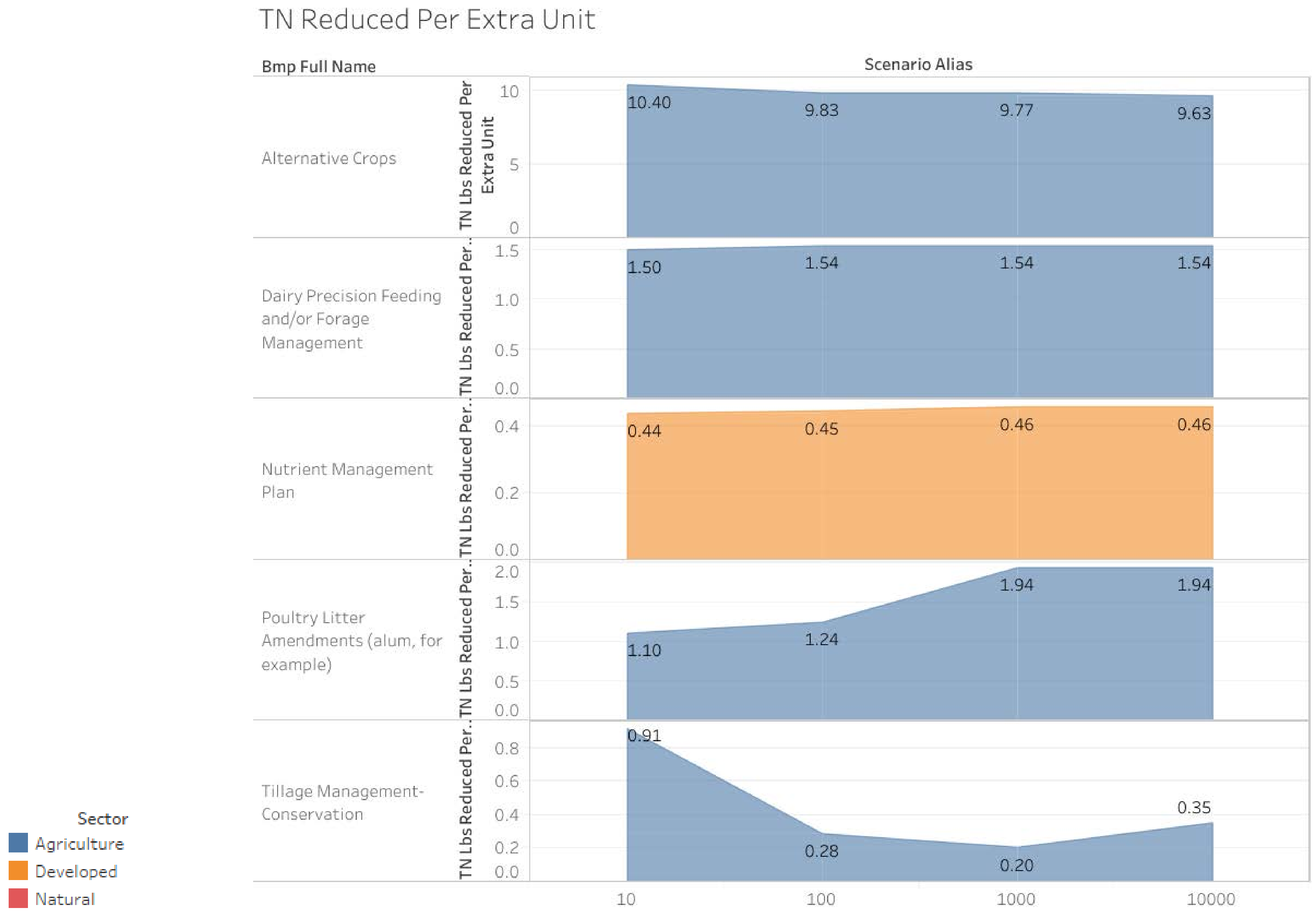


Water Quality – Bacteria Co-Benefit

Sector
- Agriculture
- Developed
- Natural

Albemarle: Results for Top 5 BMPs

Totals	Most Implemented	Most Cost Effective-TN	Most Cost Effective-TP
Nitrogen (Lbs)	83,227	83,227	26,593
Phosphorus (Lbs)	7,639	7,127	7,639
Annualized Cost	$ 2,320,913	$ 30,758	$ 91,472
Acres Treated	23,513	1,711	438



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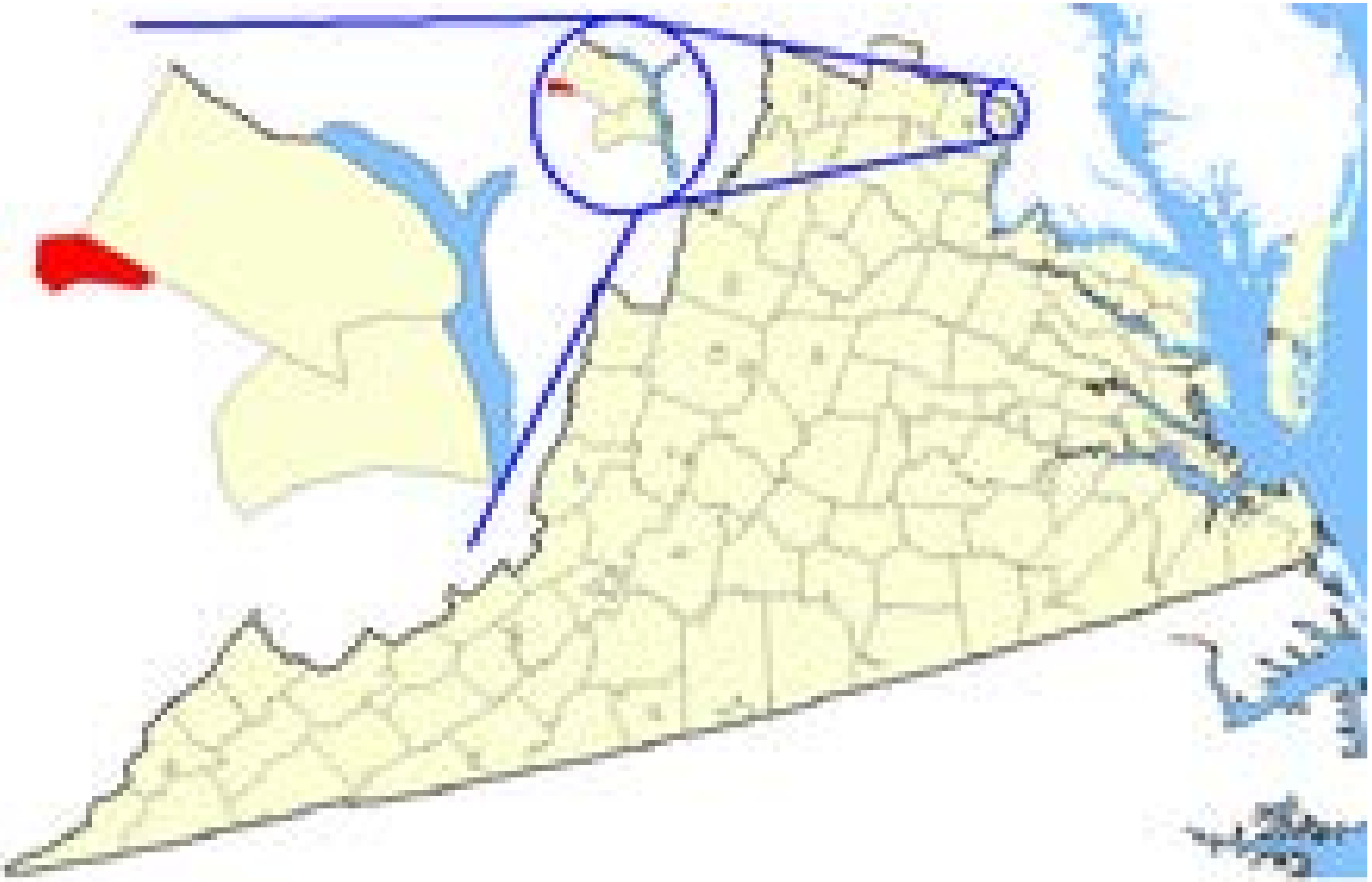
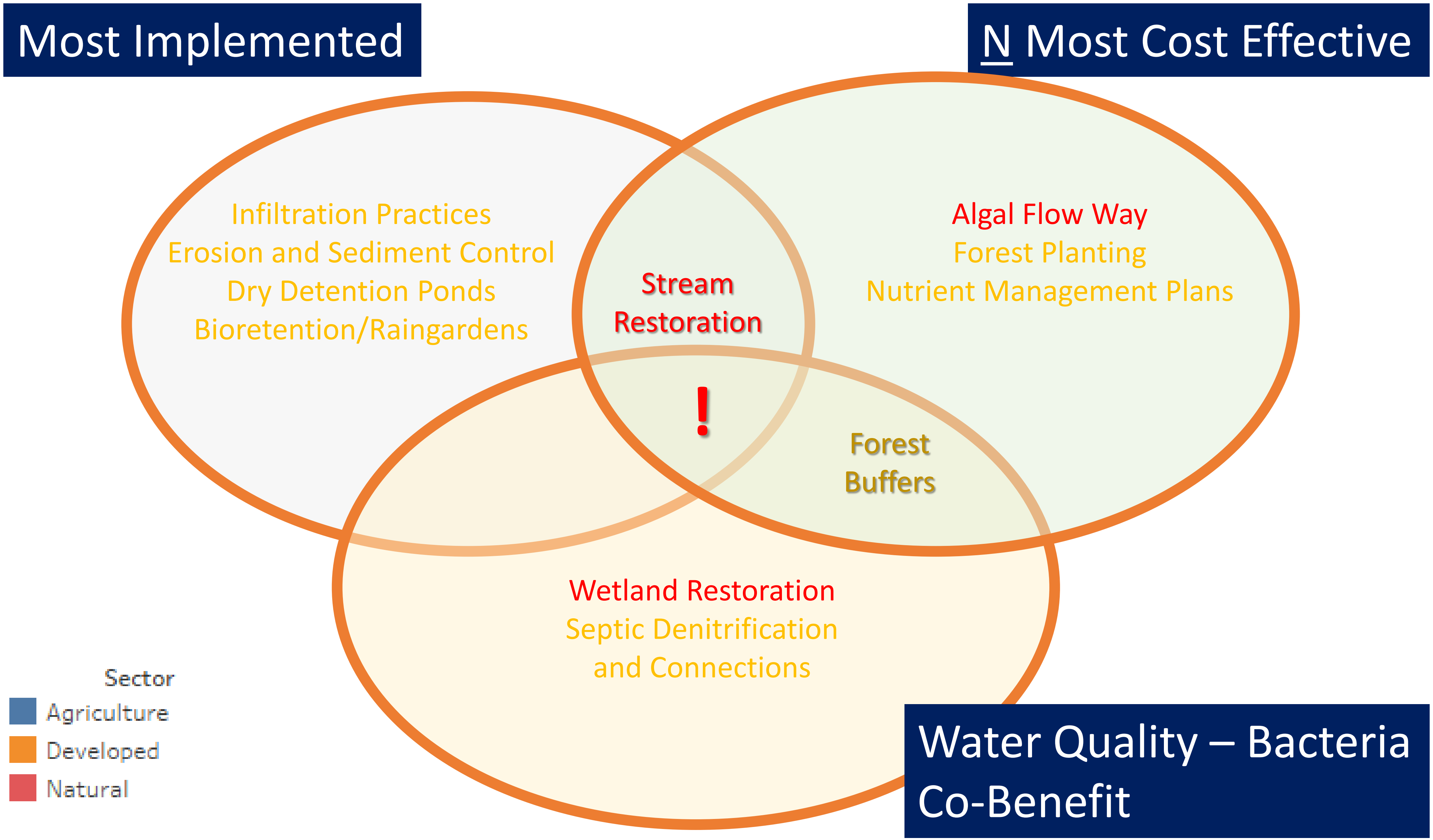
Falls Church




Most Implemented
N Most Cost Effective
Infiltration Practices
Erosion and Sediment Control
Dry Detention Ponds
Bioretention/Raingardens
Stream
Restoration
Algal Flow Way
Forest Planting
Nutrient Management Plans
!
Forest
Buffers
Wetland Restoration
Septic Denitrification
and Connections
Water Quality – Bacteria
Co-Benefit
Sector
Agriculture
Developed
Natural

Falls Church: Results for Top 5 BMPs

Totals	Most Implemented	Most Cost Effective-TN	Most Cost Effective-TP
Nitrogen (Lbs)	108	108	51
Phosphorus (Lbs)	15	9	15
Annualized Cost	$ 81,197	$ 16,609	$ 2,532
Acres Treated	48	1	21

Results

- Possible to get a substantial cost savings and exceed the N or P reductions achieved by currently implemented BMPs

- Possible to limit the number of acres that BMPs treat and exceed the N or P reductions by using more cost-effective BMPs

Caveats

- Top 5 assessment looked at the extreme of using the absolutely most cost effective BMP and did not consider
  - If the land owner would make the land available for BMPs
  - Public will to implement BMPs
  - Constraints on funding sources – some funding sources pay for certain BMPs and not others
  - MS4 permit requirements
- Case study limitations: All geographic areas need to be managed differently
- The load reduced per BMP varies geographically
  - Analysis could be done at multiple scales for any area within the Chesapeake Bay Watershed
  - Results will vary because of the geographic variation in load reduced per BMP (e.g.: Urban Forest Buffers In Montgomery County = $14 and in St. Mary’s = $12 per pound of N reduced)

Acknowledgments

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Questions?

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Extra Slides

Supporting Information

BMP Costs

- Cost per BMP is available in CAST and are based on the following
  - Capital and opportunity costs are amortized over the BMP lifespan and added to annual operations and maintenance (O&M) costs for a total annualized cost
  - The interest rate for capital and opportunity costs is 5%
  - Costs are those incurred by both public and provide entities
  - Costs represent a single year of cost rather than the cost over the entire lifespan of the practice
  - Costs are for all BMPs in a scenario, both those currently implemented as well as those planned
  - Costs were prepared for EPA using existing data
  - Bay jurisdictions were provided with the opportunity to review and amend the unit costs for BMPs in the Phase 2 WIP
  - Costs are estimated in 2010 dollars

BMP Costs

- The cost formula is:

annual costs = (capital * annualization factor) + O&M costs + (land * annualization rate)

Where:

annualization factor = $i/((1+i)^n - 1) + i$

i = annualization rate, which is always 5%

n = period of annualization (also called lifespan)

- These unit cost per BMP data support calculating the annualized cost per pound reduced per year

cost per Lb reduced per year = cost per unit of BMP / Lbs reduced per unit of BMP

- This information can enable targeting of the most effective BMPs at the lowest cost