CAST Functionality: *What's Next*

WATER QUALITY GOAL IMPLEMENTATION TEAM

OCTOBER 25 – 26, 2021

OLIVIA DEVEREUX

Overview

CAST Users

What CAST currently *can* do

Transparency in progress/CAST/NEIEN

Spatially-explicit functionality in CAST

Co-Benefits and Eco-System Services

Who is CAST for?

Technical managers within jurisdiction agencies who plan and report for the 2010 Bay TMDL
Local watershed organizations
Local government planners
Federal, state, and academic researchers

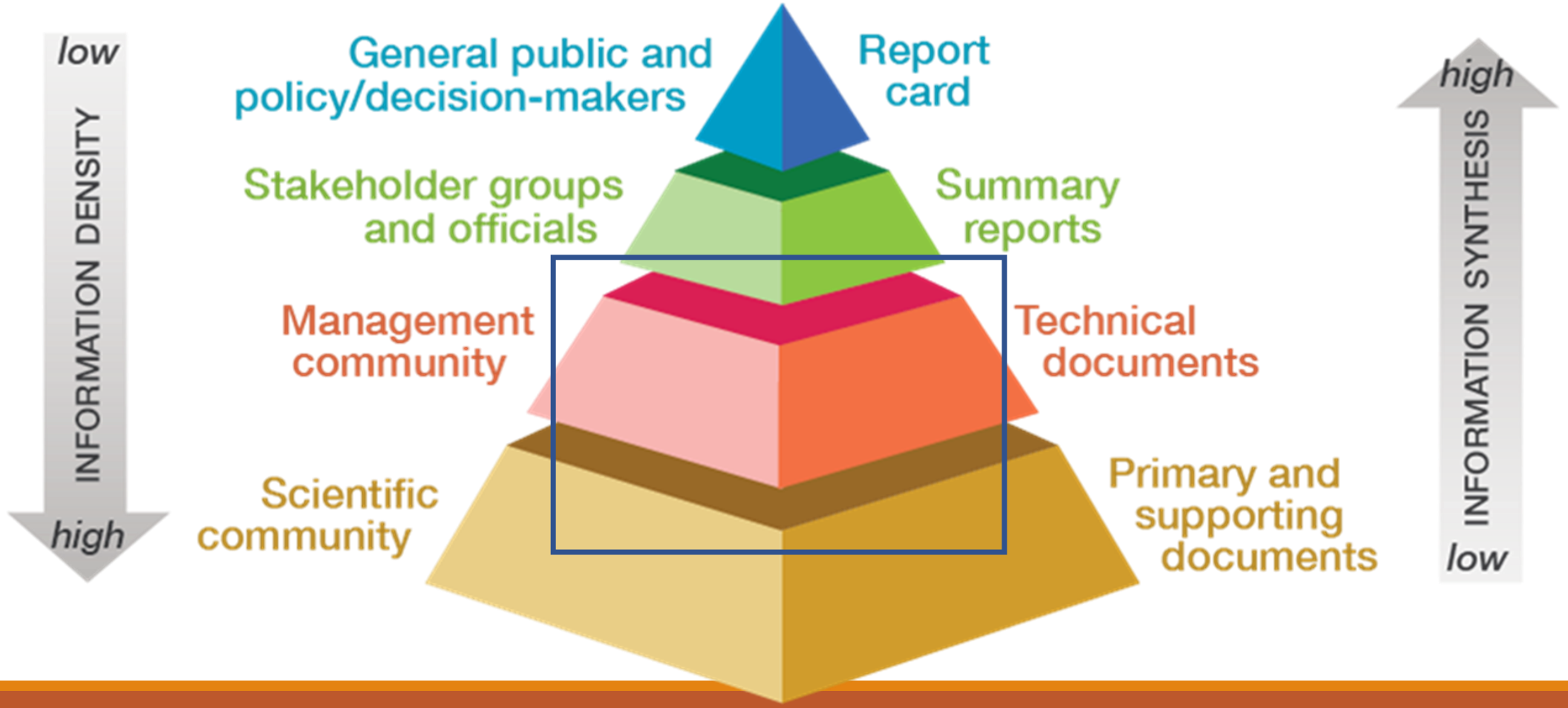


Figure courtesy UMCES Integration and Application Network, ian.umces.edu

Questions

Current

- **What are the most commonly used BMPs?**
- **What has BMP implementation changed over time?**
- **What are the lowest cost, most effective BMPs?**

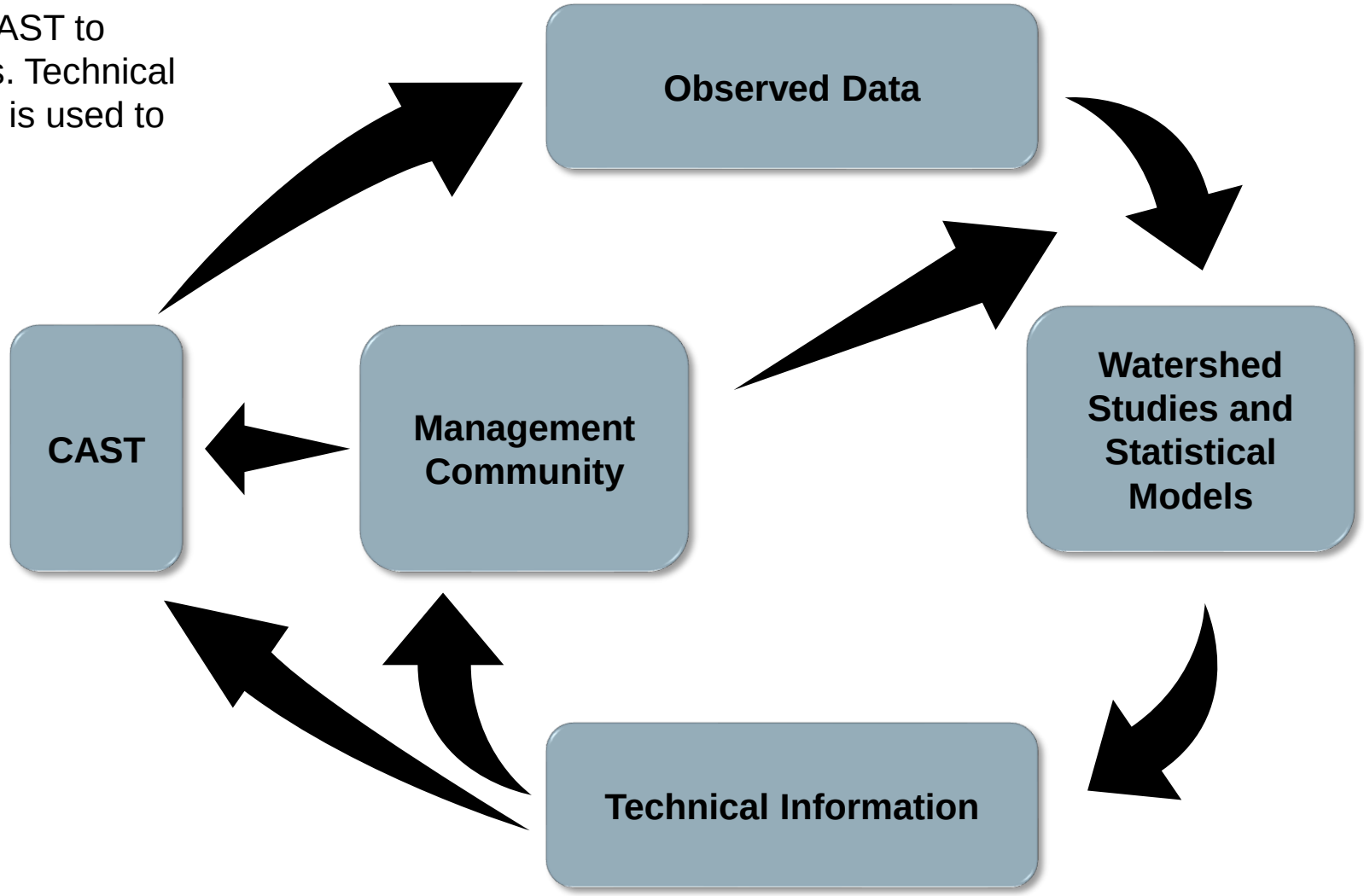
Future

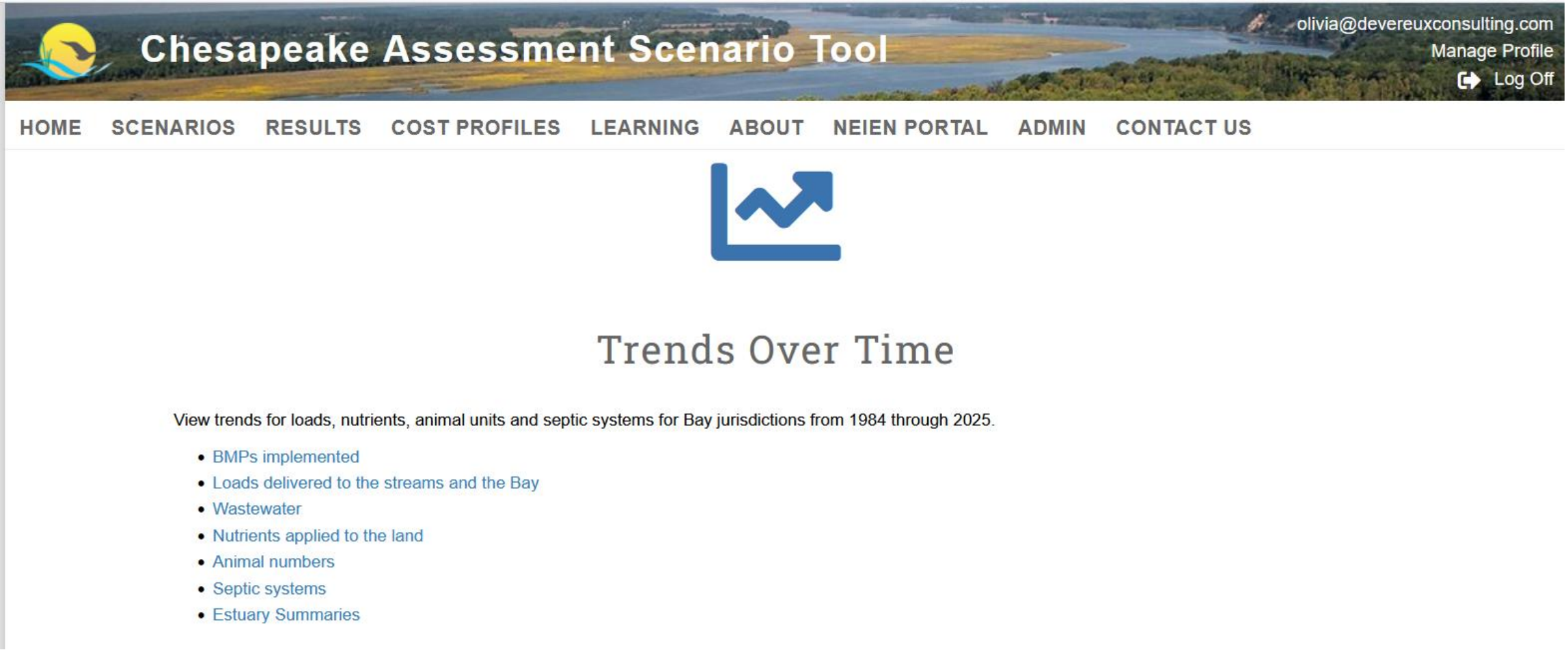
- BMP Benefits and Eco-System Services
- Spatially Explicit CAST
- Transparency in BMP annual reporting

The Chesapeake Bay watershed model (CAST) is a comprehensive synthesis of knowledge that can help direct management

The management community largely relies on CAST to understand and improve water-quality conditions. Technical information about water-quality loads and trends is used to improve and assess modeled predictions.

- **Observed data** are used to develop **watershed studies and statistical models**, based on priorities identified by the **management community**.
- **Watershed studies and statistical models** provide **technical information** that are communicated to the **management community** and used to improve **CAST**.
- The **management community** uses **CAST** to develop management strategies.
- **CAST** assesses predictions and performance against **observed data**.

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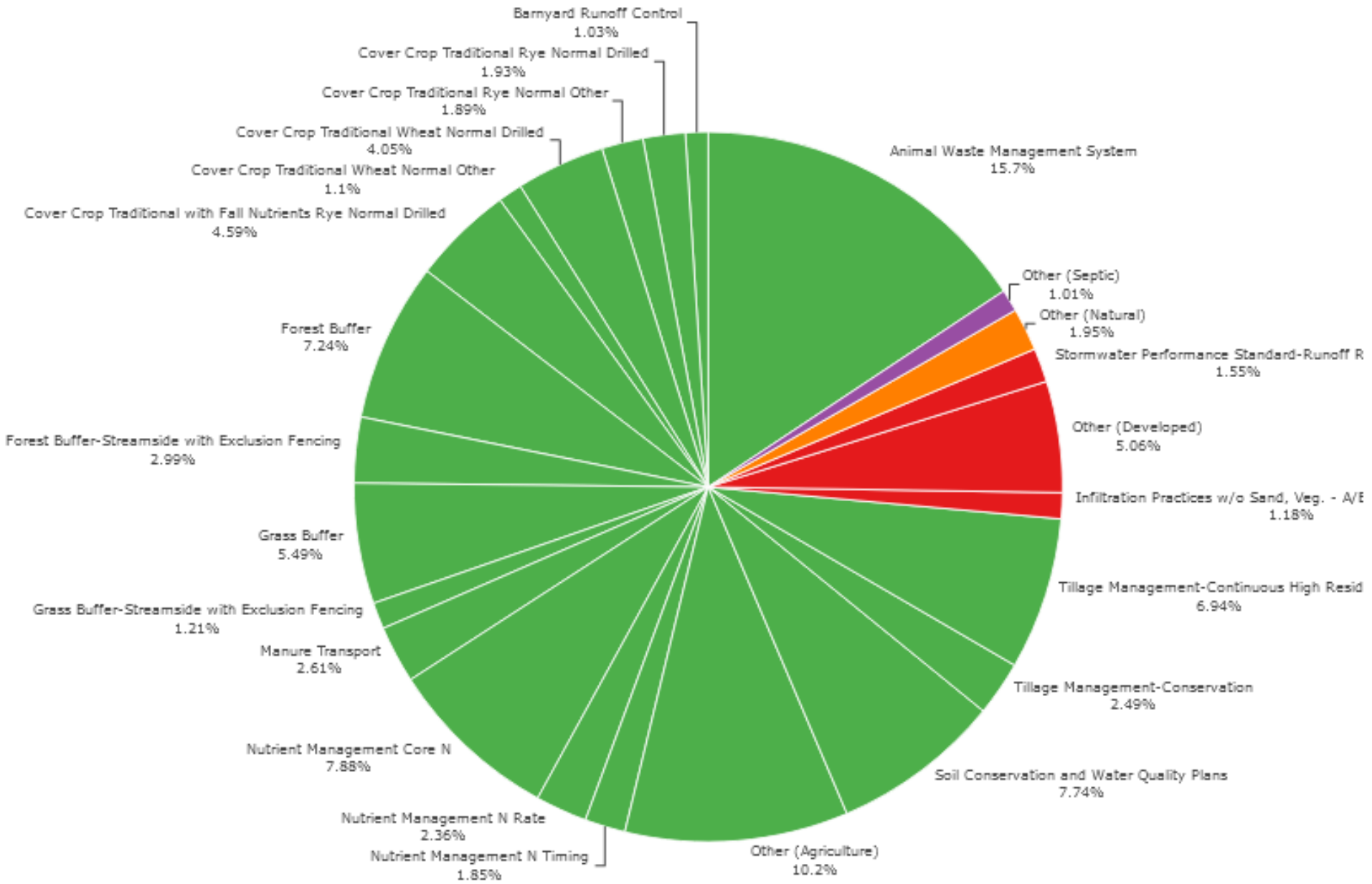
Trends Over Time
View trends for loads, nutrients, animal units and septic systems for Bay jurisdictions from 1984 through 2025.
BMPs implemented
Loads delivered to the streams and the Bay
Wastewater
Nutrients applied to the land
Animal numbers
Septic systems
Estuary Summaries

BMP Effectiveness for Nitrogen (Unweighted Percentages for Chesapeake Bay Watershed)



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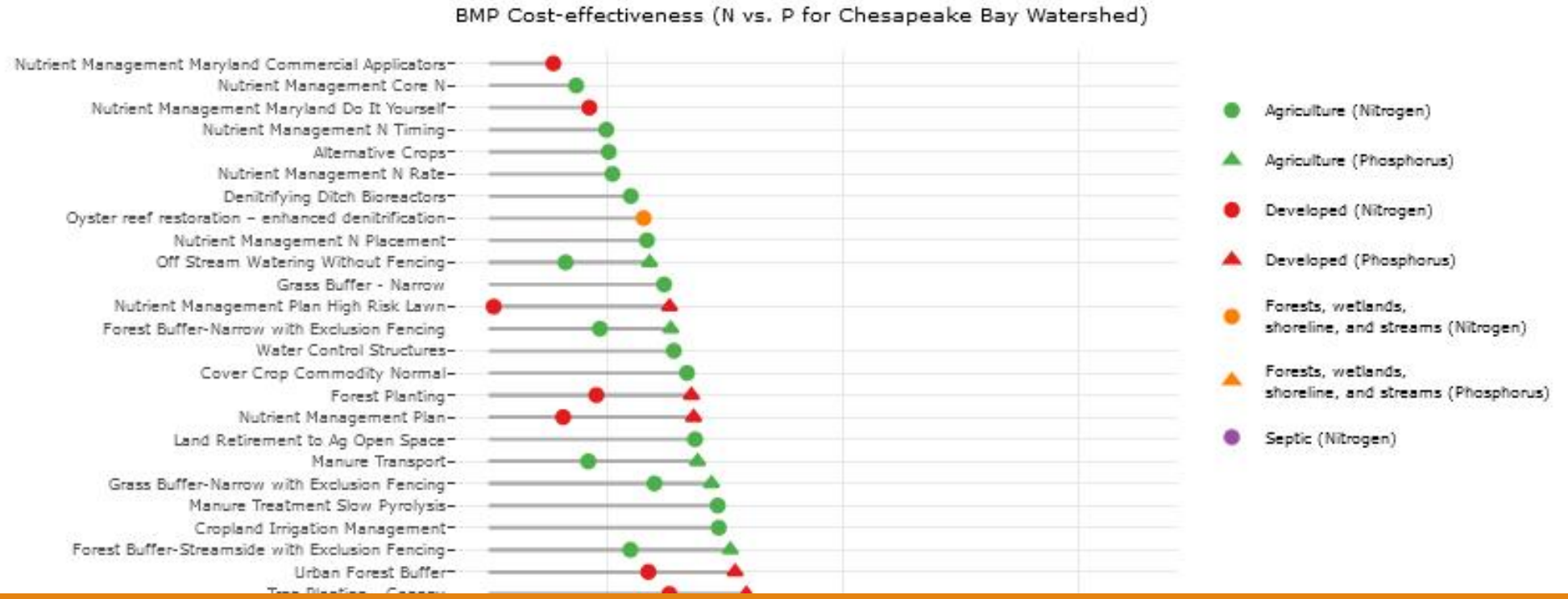
BMP Effectiveness | BMP Cost-Effectiveness | Most Implemented BMPs | Overall Costs

Choose the Geography

Chesapeake Bay Watershed



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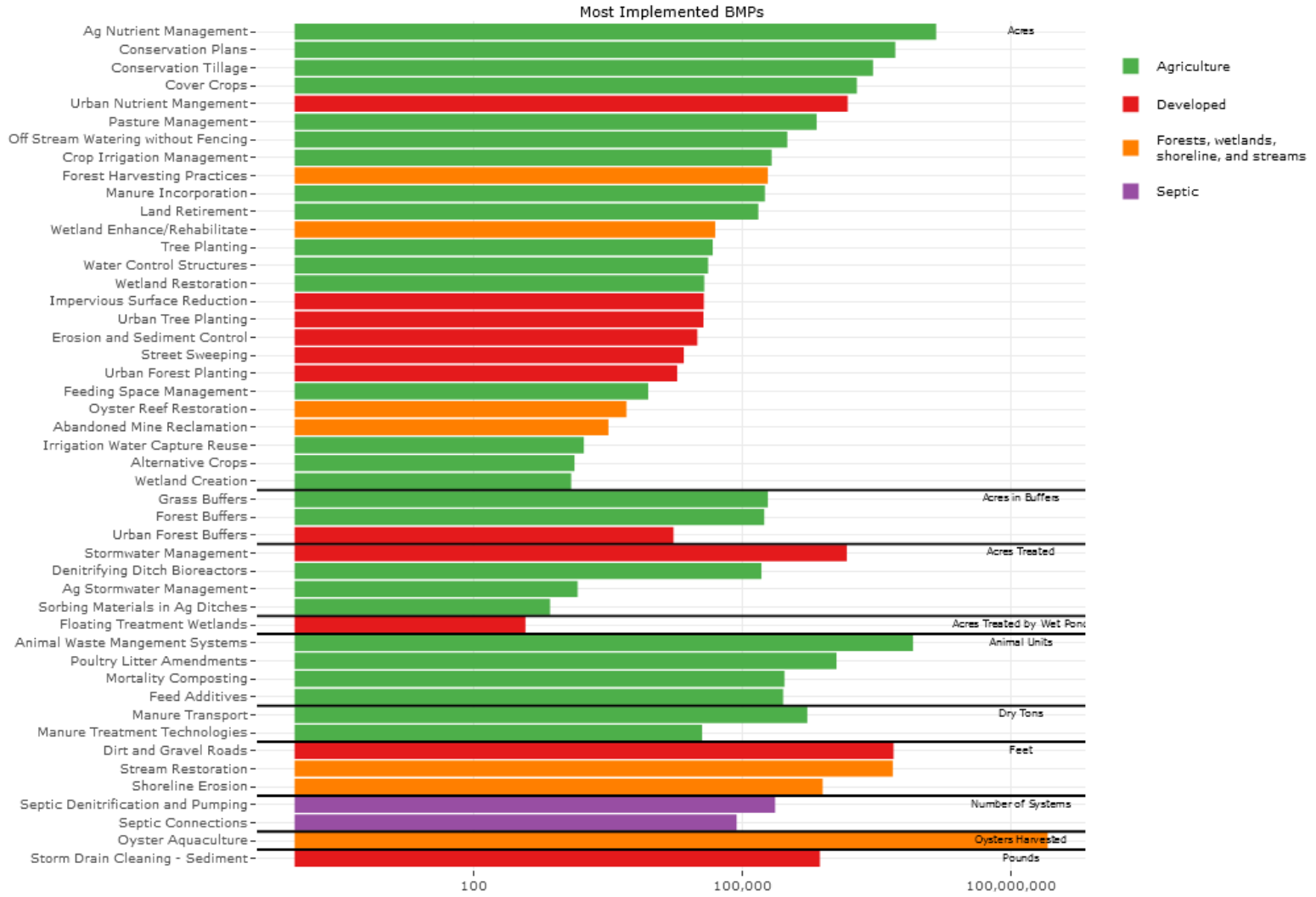
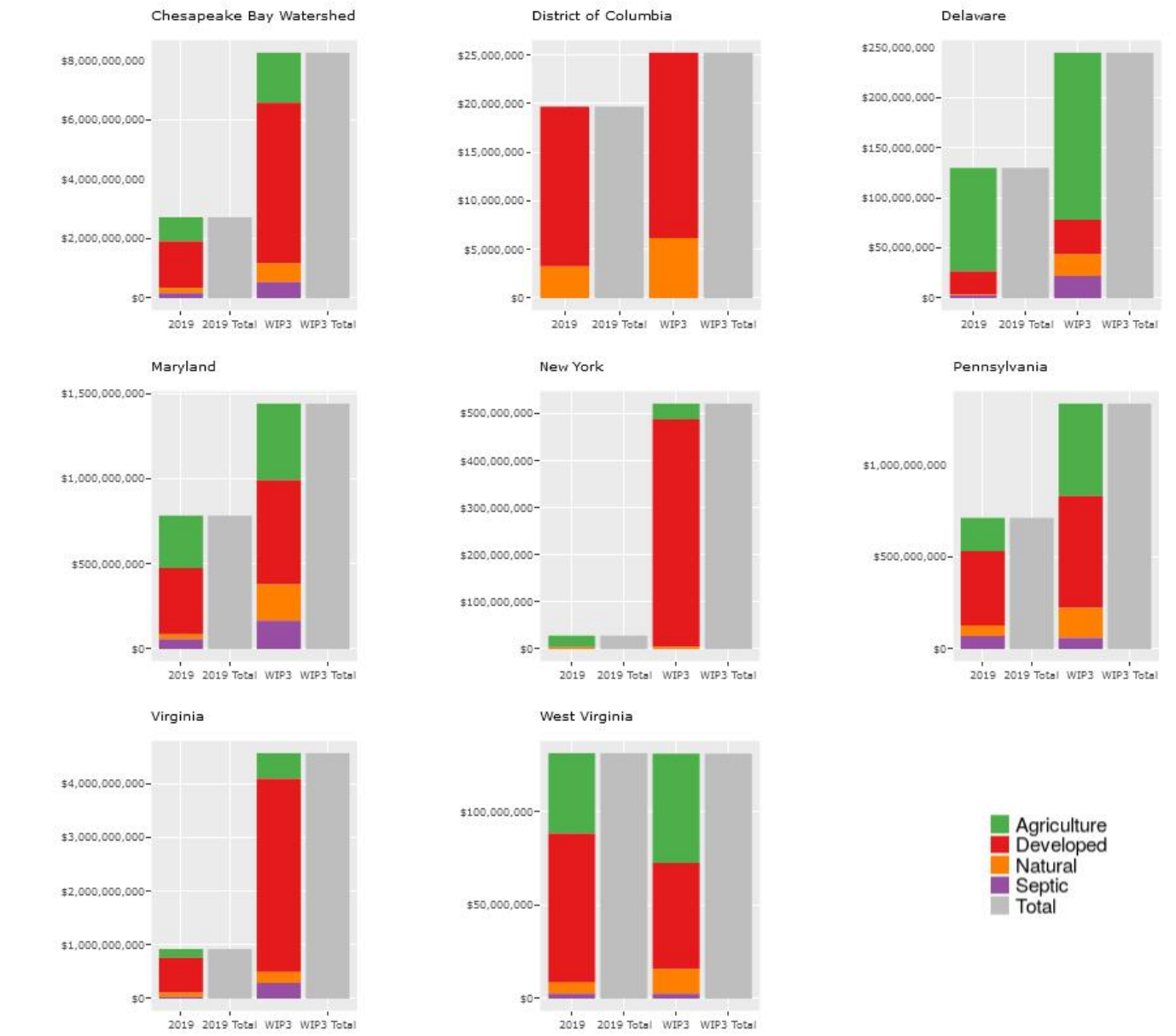
Chesapeake Bay Watershed



BMP Effectiveness | BMP Cost-Effectiveness | Most Implemented BMPs | Overall Costs

2019 and WIP3 Implementation Costs



Are most BMP investments being made in the highest loading areas of the watershed?

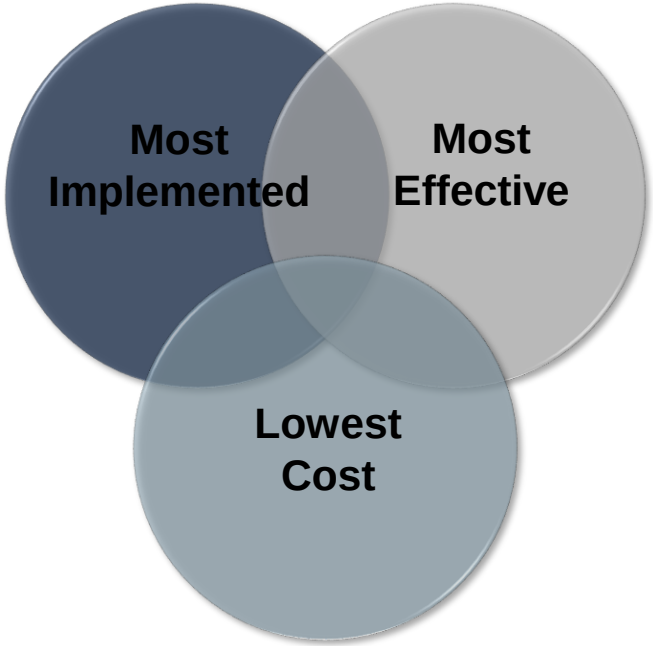
This question can be answered with CAST

CAST is a free, online nitrogen, phosphorus and sediment load estimator tool that streamlines environmental planning: cast.chesapeakebay.net

CAST provides estimates of BMP costs and expected nutrient/sediment reductions, customized by geography, that can be used to target cost effective BMPs.

In addition to targeting BMPs in high loading areas, BMPs can be targeted that offer the largest nutrient and sediment reductions at the lowest cost.

The most commonly used BMPs are not always the most cost effective. Understanding local conditions, BMP co-benefits, and cost effectiveness are some of the considerations that make up an effective management strategy.



Below: *Average cost effectiveness of nitrogen and phosphorus BMPs by source sector, as estimated by CAST.*[1]

Source Sector	Average Cost Effectiveness ($/lb reduced)	
	Nitrogen	Phosphorus
Agriculture	$108	$10,100
Developed	$7,724	$80,349
Septic	$1,006	$0
Natural*	$548	$2,461

*BMPs in the natural sector include practices such as wetland enhancements, forest harvesting practices, oyster practices, and non-urban shoreline management and stream restoration.

Learn more about these data and developing management plans by viewing CAST training videos: cast.chesapeakebay.net/Learning/FreeTrainingVideos

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Wastewater

For each municipal and industrial facility outfall, view the pounds of nitrogen or phosphorus per year. Hovering over the facilities on the map will display more detailed information.

Select a pollutant from the drop down menu, then select a year between 1985 and 2019 from the timeline.

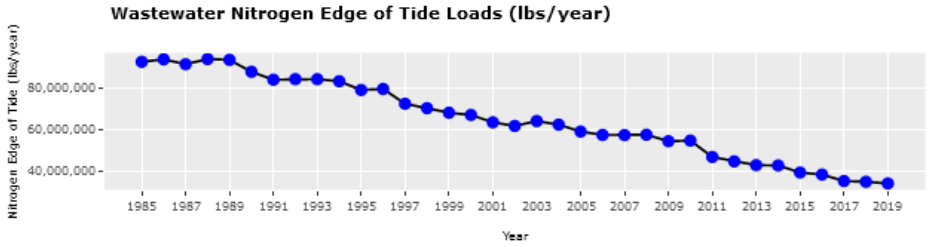
Loads at the edge of tide are the pounds delivered to the edge of the tidal area of the Chesapeake Bay and loads at the edge of stream are the pounds delivered to the edge of a perennial, small stream.

1985 2019

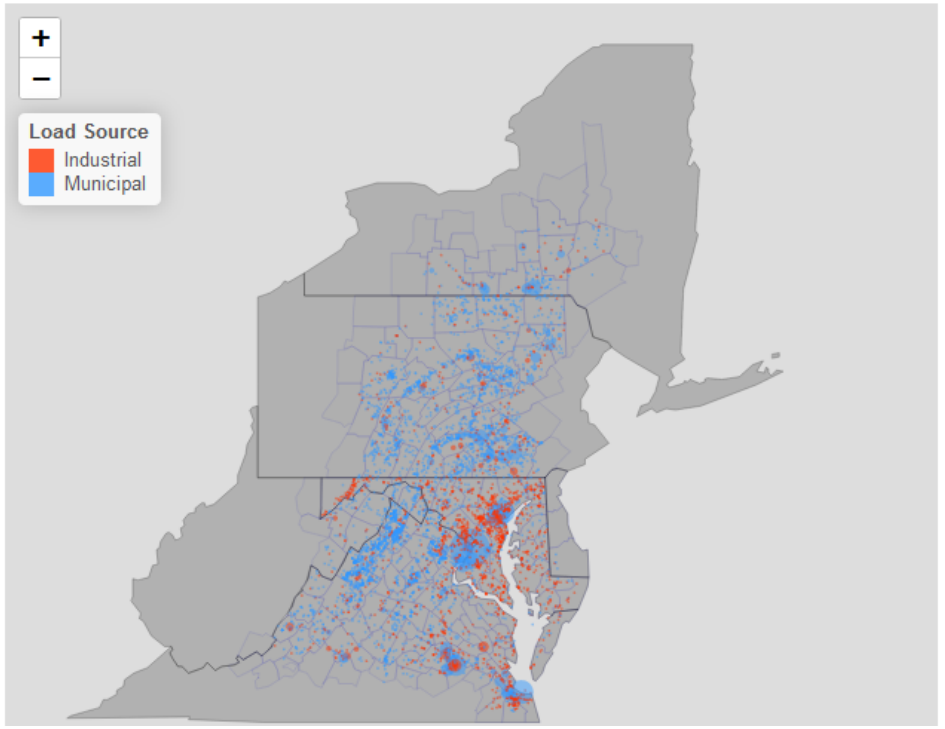
1985 1989 1993 1997 2001 2005 2009 2013 2017

Wastewater Loads by Year

Select Pollutant: Nitrogen Edge of Tide



Wastewater Facilities



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Best Management Practices (BMPs)

These graphs are intended to provide a broad representation of change over time using data provided by the seven jurisdictions that have watersheds that drain to the Bay. The jurisdictions include New York, Pennsylvania, West Virginia, Maryland, Delaware, Virginia, and Washington, D.C.

BMPs by Sector

View the amount of best management practices (BMPs) implemented by sector (i.e., Agriculture, Resource, and Urban/Suburban Practices). Select states and a range of years from 1985 through the present. Specify the unit in which the BMPs are measured. You may also choose specific BMPs if desired. In this case, the bar will stack the BMPs rather than the sectors.

BMPs by BMP Groups

View the amount of best management practices (BMPs) implemented by BMP groups. Select states and a range of years from 1985 through the present. Specify the sector and unit in which the BMPs are measured.

Note: BMPs have different levels of effects on pollutant loads. In some cases, there

BMPs by Sector | BMPs by BMP Group

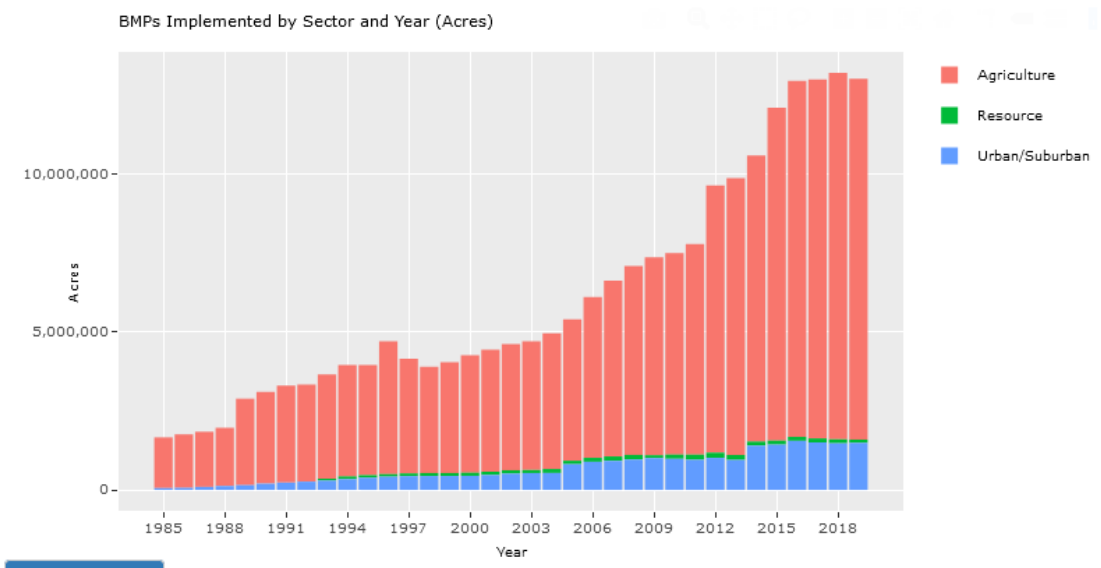
State (CBWS Only): Delaware, District of Columbia, M

Years: 1985 – 2019 (1985 1989 1993 1997 2001 2005 2009 2013 2017)

BMP Unit: Acres

BMP: Abandoned Mine Reclamation, A

Generate the graph and table



Download the data

Sector	Unique BMPs in Graph
Agriculture	Agricultural Drainage Management

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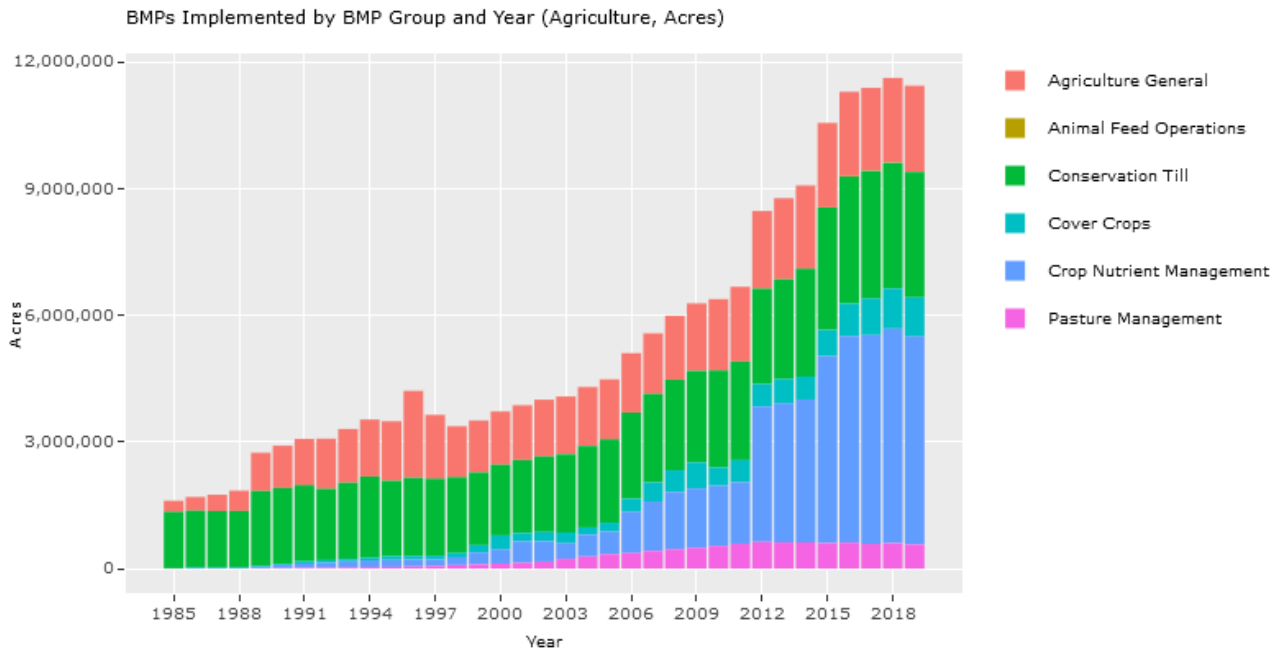
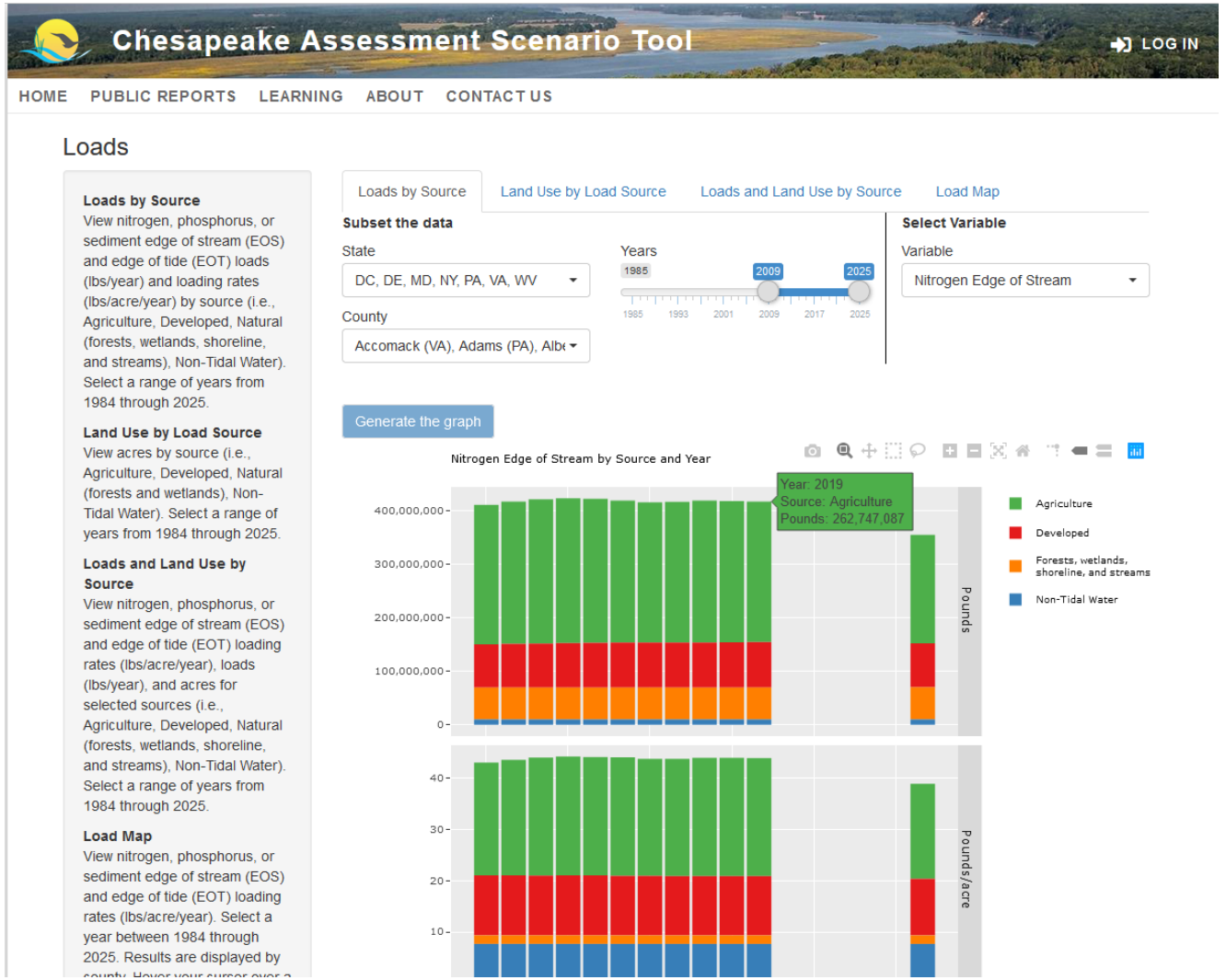
BMP Sector: Agriculture, Acres

Generate the graph

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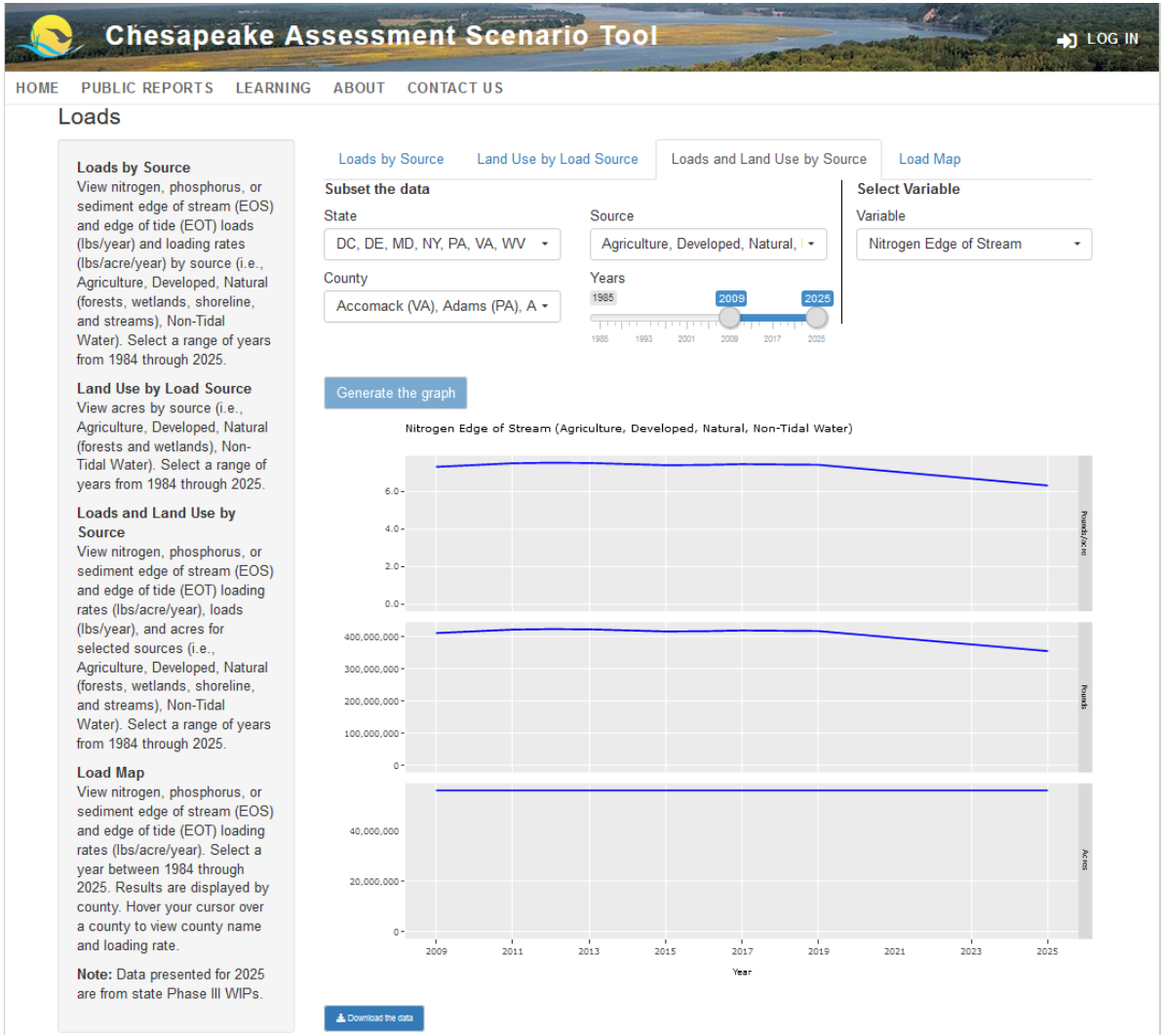
Loads
Loads by Source
View nitrogen, phosphorus, or sediment edge of stream (EOS) and edge of tide (EOT) loads (lbs/year) and loading rates (lbs/acre/year) by source (i.e., Agriculture, Developed, Natural (forests, wetlands, shoreline, and streams), Non-Tidal Water). Select a range of years from 1984 through 2025.
Land Use by Load Source
View acres by source (i.e., Agriculture, Developed, Natural (forests and wetlands), Non-Tidal Water). Select a range of years from 1984 through 2025.
Loads and Land Use by Source
View nitrogen, phosphorus, or sediment edge of stream (EOS) and edge of tide (EOT) loading rates (lbs/acre/year), loads (lbs/year), and acres for selected sources (i.e., Agriculture, Developed, Natural (forests, wetlands, shoreline, and streams), Non-Tidal Water). Select a range of years from 1984 through 2025.
Load Map
View nitrogen, phosphorus, or sediment edge of stream (EOS) and edge of tide (EOT) loading rates (lbs/acre/year). Select a year between 1984 through 2025. Results are displayed by
Loads by Source
Land Use by Load Source
Loads and Land Use by Source
Load Map
Subset the data
State
DC, DE, MD, NY, PA, VA, WV
County
Accomack (VA), Adams (PA), Albe
Years
1985
2009
2025
1985 1993 2001 2009 2017 2025
Select Variable
Variable
Nitrogen Edge of Stream
Generate the graph
Nitrogen Edge of Stream by Source and Year
Year: 2019
Source: Agriculture
Pounds: 262,747,087
400,000,000
300,000,000
200,000,000
100,000,000
0
Pounds
40
30
20
10
Pounds/acre
Agriculture
Developed
Forests, wetlands, shoreline, and streams
Non-Tidal Water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Load Map
View nitrogen, phosphorus, or sediment edge of stream (EOS) and edge of tide (EOT) loading rates (lbs/acre/year). Select a year between 1984 through 2025. Results are displayed by county. Hover your cursor over a county to view county name and loading rate.
Note: Data presented for 2025 are from state Phase III WIPs.
Loads by Source
Land Use by Load Source
Loads and Land Use by Source
Load Map
Subset the data
State
DC, DE, MD, NY, PA, VA, WV
Source
Agriculture, Developed, Natural,
County
Accomack (VA), Adams (PA), A
Years
1985
2009
2025
Select Variable
Variable
Nitrogen Edge of Stream
Generate the graph
Nitrogen Edge of Stream (Agriculture, Developed, Natural, Non-Tidal Water)
6.0
4.0
2.0
0.0
Pounds/Acre
400,000,000
300,000,000
200,000,000
100,000,000
0
Pounds
40,000,000
20,000,000
0
Acres
2009
2011
2013
2015
2017
2019
2021
2023
2025
Year
Download the data

Loads by Source
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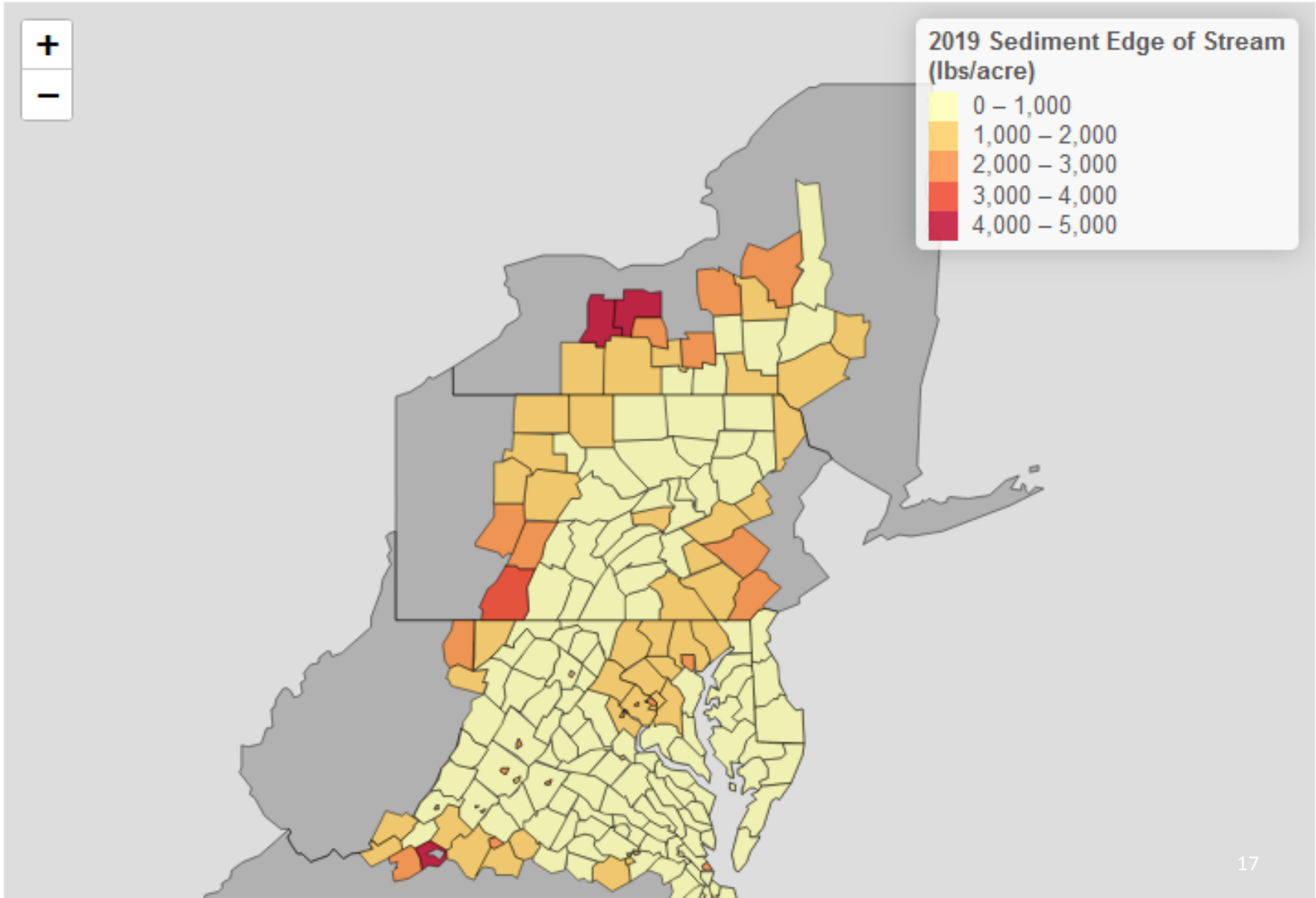
Load Map

Loads by Source | Land Use by Load Source | Loads and Land Use by Source | Load Map

Year: 2019

Nutrient: Sediment Edge of Stream



Which BMPs are most likely to result in a water-quality benefit?

This question can be answered with CAST
CAST is a free, online nitrogen, phosphorus and sediment load estimator tool that streamlines environmental planning.

- Explore nutrient sources, application rates, and land use patterns: cast.chesapeakebay.net/TrendsOverTime/NutrientsApplied
- Explore BMP implementation patterns by source sector and geography: cast.chesapeakebay.net/TrendsOverTime/BMPs
- Explore BMP cost profiles: cast.chesapeakebay.net/Documentation/CostProfiles

The **Chesapeake Bay Phase 6 Land Use Viewer** can be used to explore land use patterns throughout the watershed is accessible from:
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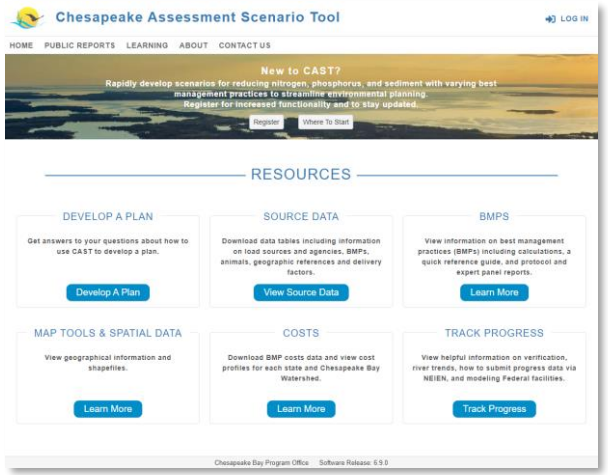
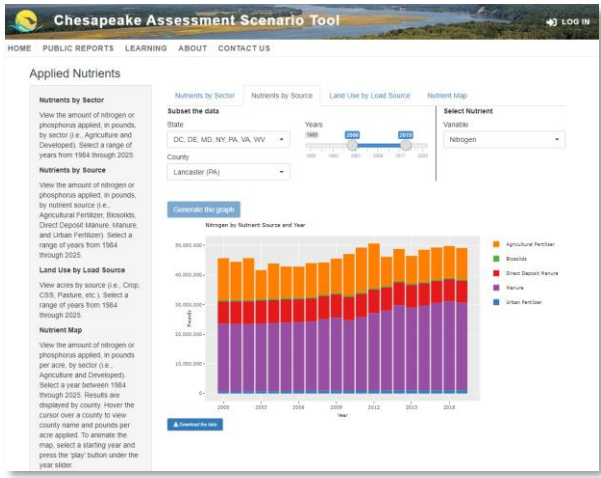
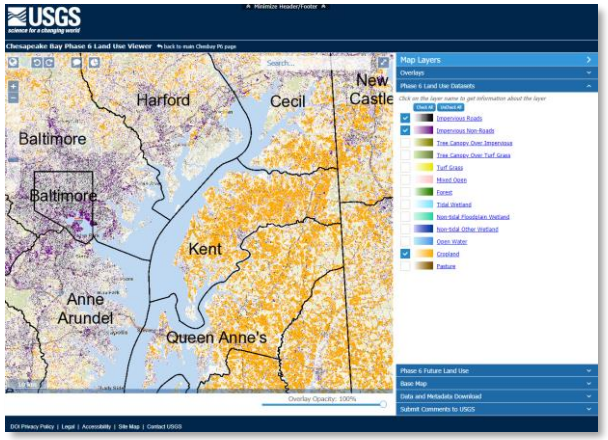
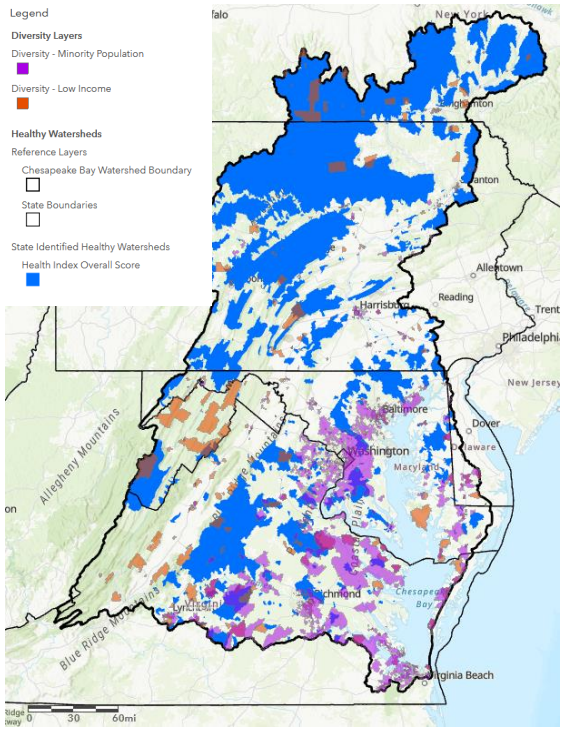


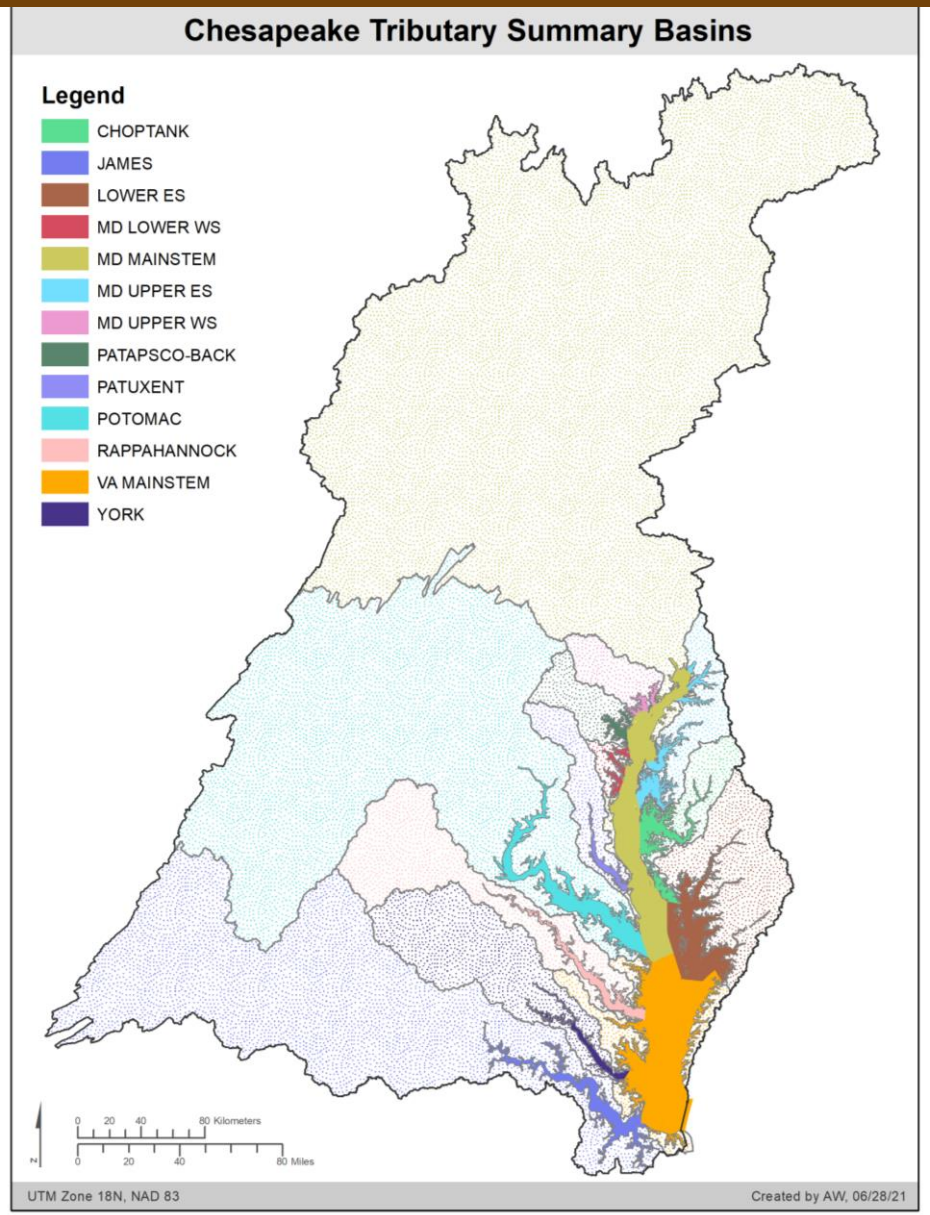






***Above**: Screenshots of online tools and resources that can help guide effective watershed management.*

12 Tributary Trend Summaries



- **Maryland Mainstem** *(The 5 Chesapeake Bay mainstem segments within the MD state boundary. Drainage basins include the Susquehanna River and upper Chesapeake shorelines)*
- **Maryland Upper Eastern Shore** *(The Northeast, Bohemia, Elk, Back Creek, Sassafras, and Chester Rivers, the C&D Canal, and Eastern Bay)*
- **Choptank** *(the Choptank, Little Choptank, and Honga)*
- **Maryland Upper Western Shore** *(Bush, Gunpowder, Middle Rivers)*
- **Patapsco & Back Rivers**
- **Patuxent** *(includes the Western Branch tributary)*
- **Potomac**
- **Rappahannock** *(includes the Corrotoman tributary)*
- **York** *(includes the Mattaponi and Pamunkey tributaries)*
- **James** *(includes the Appomattox, Chickahominy, and Elizabeth tributaries)*
- **Lower E. Shore** *(includes the Nanticoke, Manokin, Wicomico, Big Annemessex, and Pocomoke rivers & Tangier Sound)*
- **Virginia Mainstem** *(no summary but Appendices are provided)*

Questions the tributary summaries can answer

1. Have water quality indicators in my river been improving or degrading over time?

2. How have landscape factors that drive water quality change in my watershed changed over time?

3. What clues do they provide that might explain observed water quality change (or lack of change)?

4. What should I target to turn a degrading trend around or maintain improvements for future water quality and living resource conditions?

5. What should scientists focus our analyses on to provide better answers in the future?

Questions

Current

- What are the most commonly used BMPs?
- What has BMP implementation changed over time?
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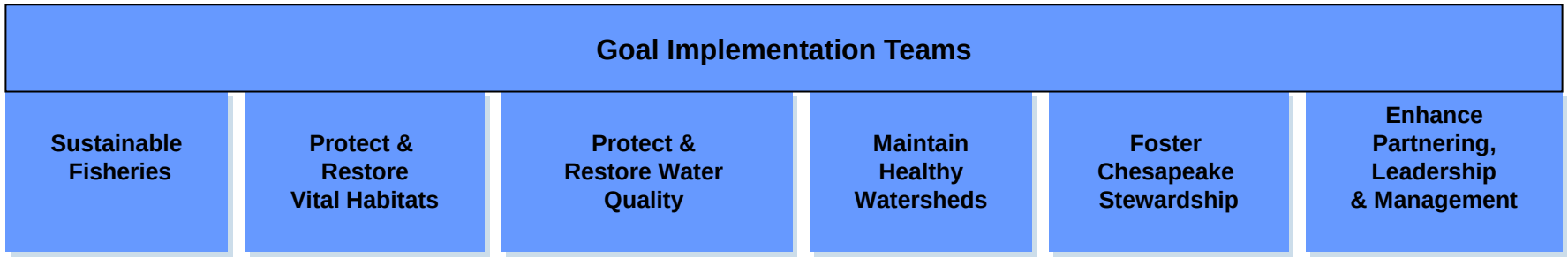
Future

- **BMP Benefits and Eco-System Services**
- **Spatially Explicit CAST**
- **Transparency in BMP annual reporting**



Habitat Outcomes

- Black Duck
- Brook Trout
- Fish Passage
- Forest Buffers
- SAV
- Stream Health
- Tree Canopy
- Wetlands

The responses to these questions can inform future actions and programs

Questions

- What are the dominant BMPs where Chessie BIBI scores have improved over time?
- How has land use changed over time where scores have in/decreased?
- What has the level of financial investment been in watersheds with increasing Chessie BIBI scores?

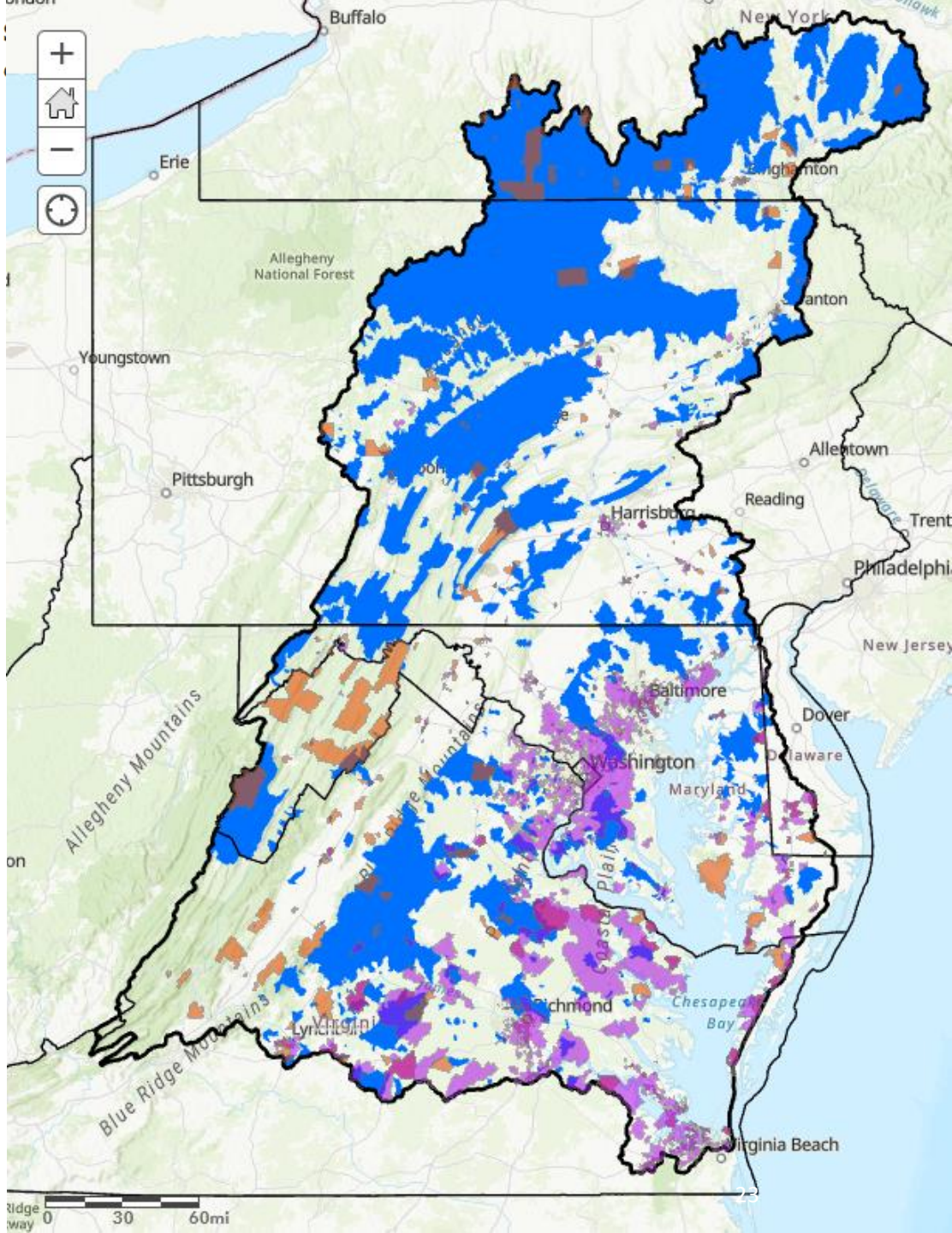
What is needed to add Stream Health to CAST

Research needed—Chessie BIBI for a 10+ year timespan

Cross-GIT map use

- Include Diversity Layers

BMPs



Legend

Diversity Layers

Diversity - Minority Population

Diversity - Low Income

Healthy Watersheds

Reference Layers

Chesapeake Bay Watershed Boundary

State Boundaries

State Identified Healthy Watersheds

Health Index Overall Score

Trade-offs for some outcomes

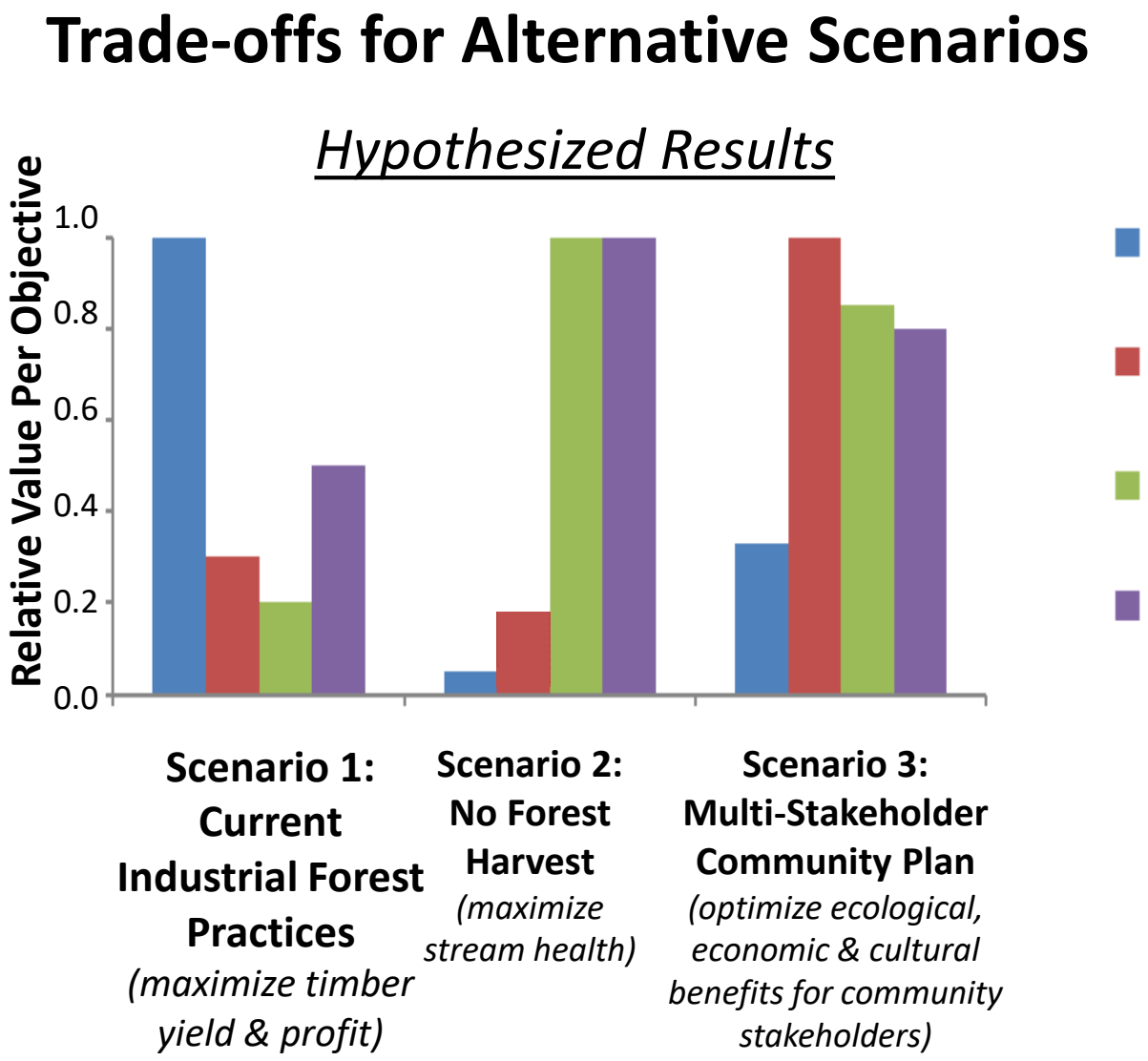
Identify habitat restoration priorities

- Stream health, woody debris, forest buffers

Determine how much restoration and where

Scenarios for balancing diverse objectives

- Stream health, black ducks, timber, local jobs, recreation, sport fishing



Link BMP Planning to Spatially Explicit Land Use

+ Add BMP

Add BMP

*Required field

Agency * Select Agency

BMP * Select BMP

Secondary BMP * Select BMP

Unit * Select Unit

Amount *

Add Cancel

Benefit to Restoration Professionals

Enhance CAST users' ability to improve water quality and focus measured outcomes to smaller geographic scales

Increase understanding of CAST by non-technical people, which will expand usage of CAST to conservation project members, farmers, and farm advisors

Negate the need for urban planners to convey their site-specific geographic information out of CAST and into separate spreadsheet tools that produce inconsistent results

Facilitate incorporation of Cross-GIT mapping layers like brook trout, toxics, and BIPOC populations

Connect co-benefits and eco-system services to restoration planning

Timeline and Required Investment

It is expected that this could be done in about 2 years.

Costs are estimated to be about $300,000.

The capacity to undertake this work does not currently exist within the Chesapeake Bay Program Development Team.

Previous experience with modelers at Drexel University suggests that they would have the experience and knowledge to develop a spatially explicit version of CAST. They would provide a supplement to our existing Development Team to ensure that usability and CAST user experience would be consistent across the products.

Integrating the land use, non-water quality benefits and ecosystem services with the assessment functionality and official progress scenarios

This question can be answered with CAST
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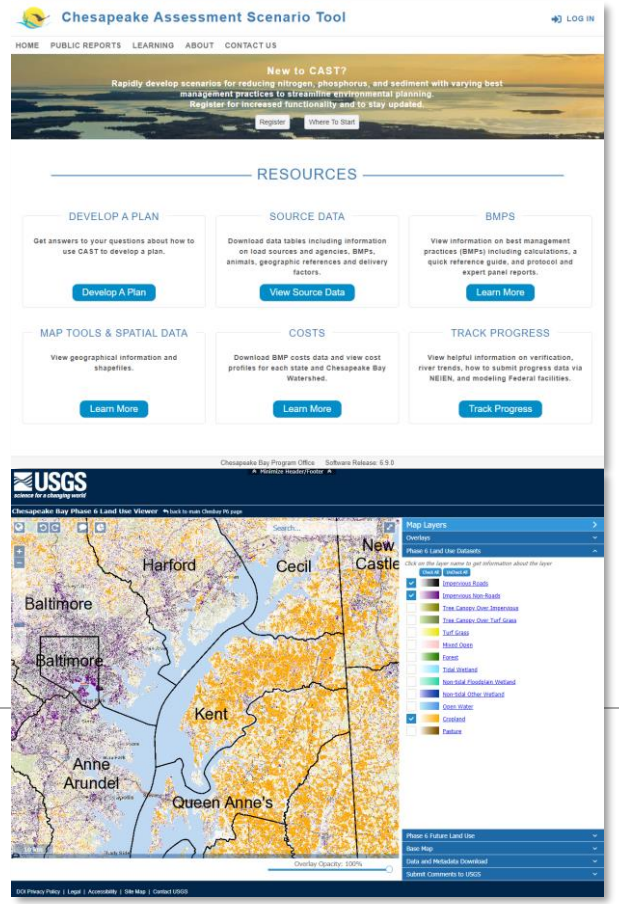
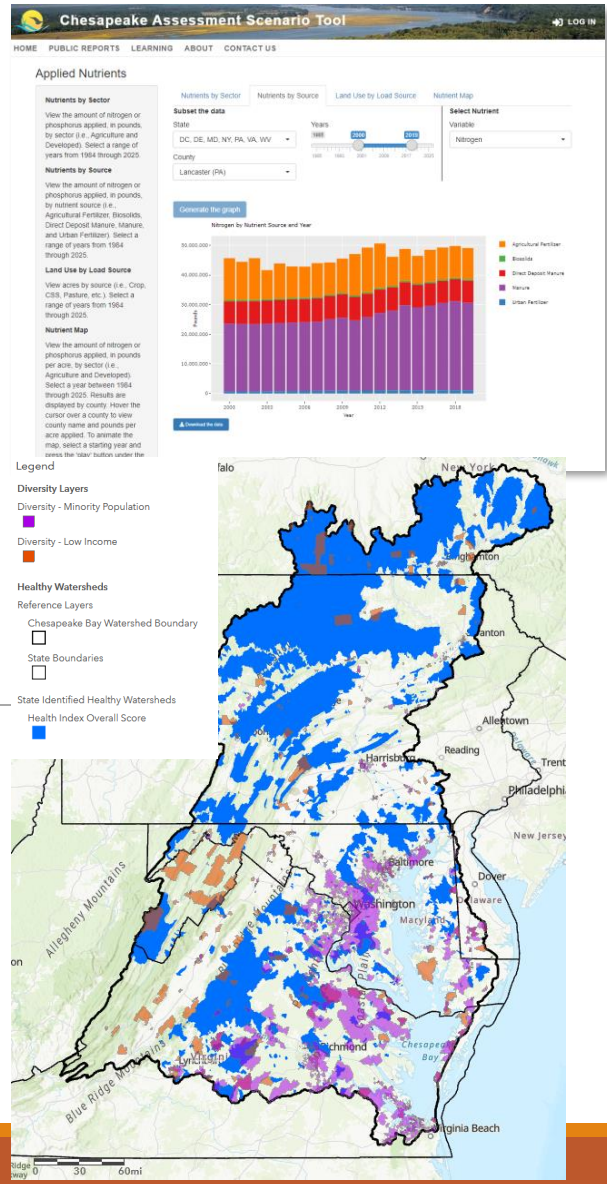
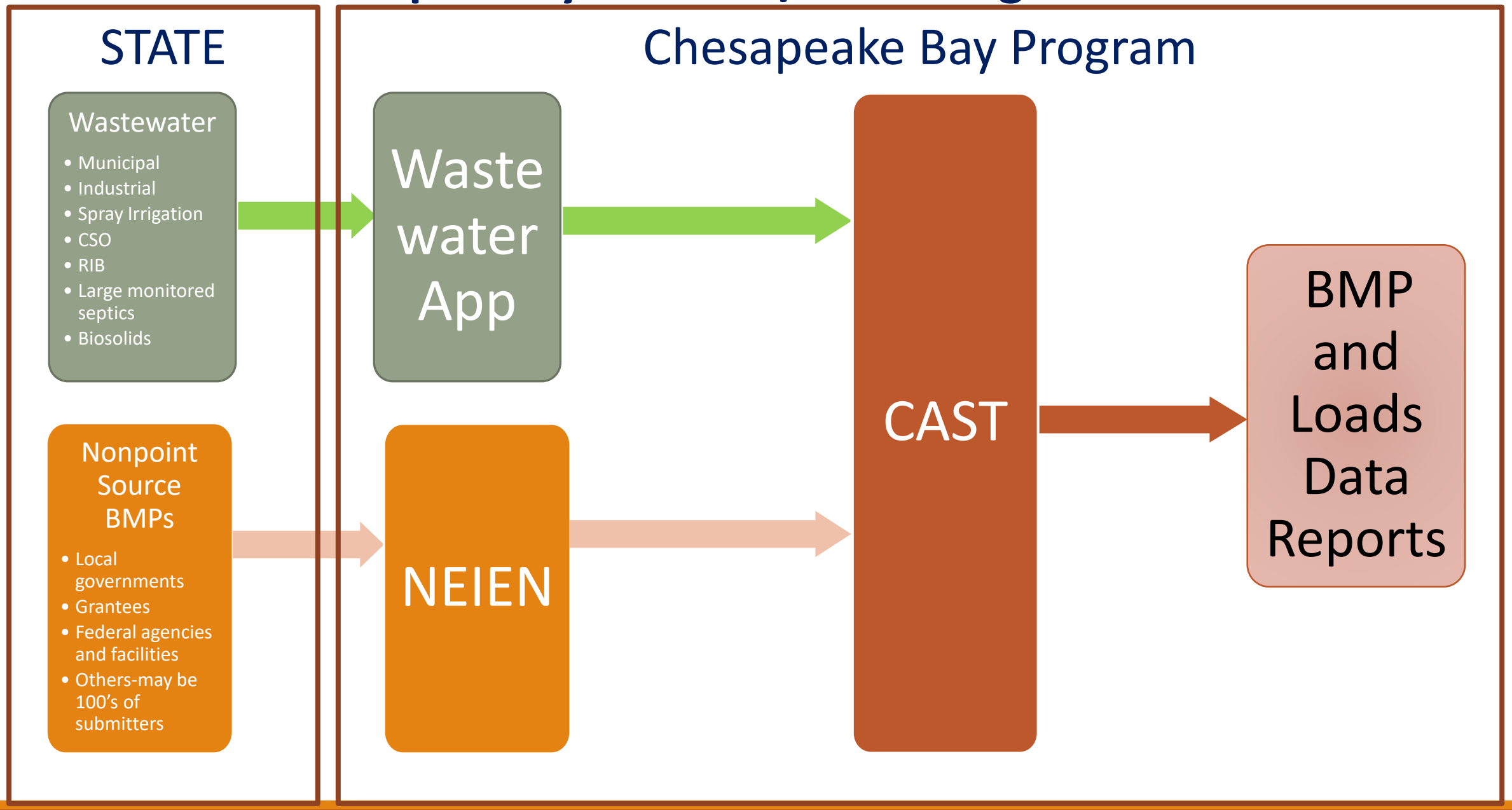




***Above**: Screenshots of online tools and resources that can help guide effective watershed management.*

Transparency in NEIEN/CAST Progress data



NEIEN BMP Errors

B16: 2955

	A	B	C	D	E	F	G	H	
1	ERROR_MESSAGE	submission_id	SUBMISSION_DATE	transaction_id	YEAR	state_unique_id	agency_code	state_code	bmp_nam
2	The status of the BMP is Draft, Retired or NA.	2955.00000	11/18/2020 10:27:48	_33efa163-37aa-436a-9cff-6abf9ce57c8e	2010.00000	MTD-2011-000038624	2017125-116	VA	Proprietary
3	The status of the BMP is Draft, Retired or NA.	2955.00000	11/18/2020 10:27:48	_33efa163-37aa-436a-9cff-6abf9ce57c8e	2010.00000	MTD-2011-000038623	2017125-116	VA	Proprietary

NEIEN Inspection Report

B7091: VDH-2008-000011751

	A	B	C	D	E	F	G	
1	ERROR_MESSAGE	state_unique_id	agency_code	state_code	bmp_name	life_span	GEOGRAPHY_NAME	im

CAST Land BMP Submission Errors

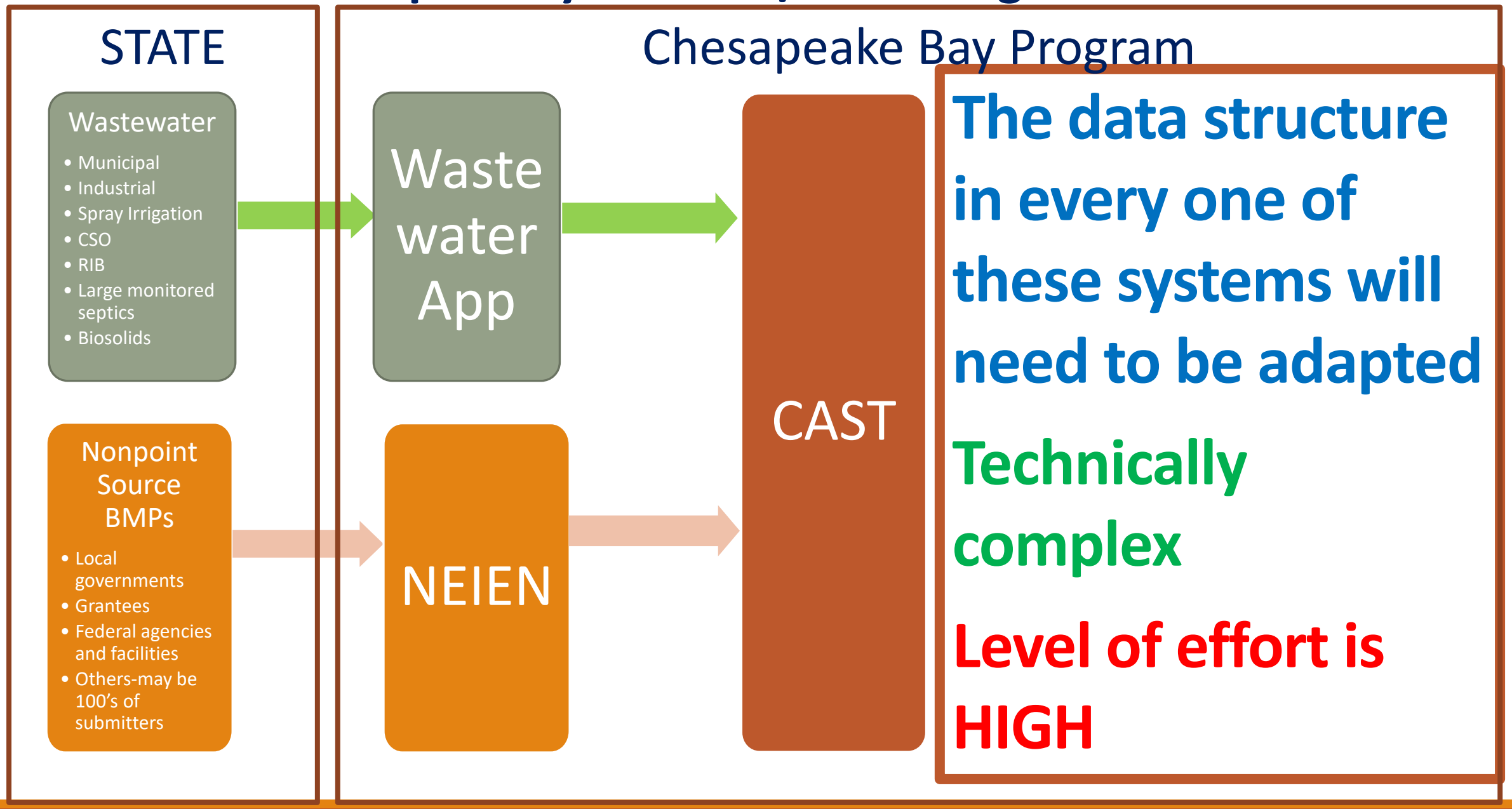
A1: ErrorMessage

CAST Credited v. Submitted Report

A1: StateAbbreviation

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	StateAbbr	Geograph	Geograph	Agency	BMPShort	BMP	BMPType	Unit	Sector	FromLoad	ToLoadSo	AmountSu	AmountBa	AmountNc	AmountCr	Excess	TotalAmou	Cost
2	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	Non-Regul	Non-Regul	16.857	0.055	16.802	16.802	0.000	16.857	########
3	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	Non-Regul	Non-Regul	60.664	0.556	60.108	60.108	0.000	60.664	########
4	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	Non-Regul	Non-Regul	7.178	0.071	7.107	7.107	0.000	7.178	########
5	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	MS4 Roads	MS4 Turf C	0.180	0.006	0.174	0.174	0.000	0.180	########
6	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	MS4 Buildi	MS4 Turf C	0.041	0.002	0.039	0.039	0.000	0.041	2350.879
7	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	MS4 Tree (	MS4 Tree (	0.024	0.001	0.023	0.023	0.000	0.024	1356.906
8	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	CSS Roads	CSS Roads	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	CSS Buildi	CSS Buildi	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	MD	md	Maryland	Departmen	impsurred	Impervious	Landuse C	Acres	Developed	CSS Tree (	CSS Tree (	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	MD	md	Maryland	Departmen	urbstrmres	Urban Stre	Pound Red	Feet	Natural	Stream Be	Stream Be	########	0.000	########	########	0.000	########	########

Transparency in NEIEN/CAST Progress data



Summary

Goals

- Provide federal, state, and local partners and stakeholders **tools and information** for ecological improvement in the Bay
- **Quantify** the link between BMPs and ecological conditions

Strategy for making changes

- Adapt CAST to **include additional benefits** (low-high)
- Add **spatially-explicit land use** for planning (medium)
- **Transparency in NEIEN/CAST progress BMP** data (high)
- Redesign the **interface** (medium)

Near-term goals

- Continue working with Goal Teams to make CAST an effective tool to **show comprehensive recovery solutions** across habitats and scales
- Identify **data gaps**

Contaminated sites → Revitalized communities

Citizen stewardship, Diversity, Local Leadership

Questions?