Load Calculation in CAST

Gary Shenk 9/8/2023

CAST Structure

CAST is a simple model

Inputs (Fertilizer, Manure, Atmospheric Deposition, Fixation, Wastewater)

*

Land management

*

Watershed Delivery

Load by land-river segment and land use

CAST Structure

Average Load

+

△ Inputs * Sensitivity

*

BMPs

*

Acres

*

Land to Water

*

River Delivery

Average nitrogen load to stream for double cropped ag land watershed wide is 32 pounds per acre

Load by land-river segment and land use

CAST Structure

Average Load

+

△ Inputs * Sensitivity

*

BMPs

*

Acres

*

Land to Water

*

River Delivery

Load by land-river segment and land use

Your area applies 115 pounds of fertilizer while the watershed-wide average is 140.

Each additional pound of fertilizer results in 0.2 lbs of runoff

32 + (115-140) * 0.2 = 27 lbs/acre

5

CAST Structure

Average Load

+

△ **Inputs * Sensitivity**

*

BMPs

*

Acres

*

Land to Water

*

River Delivery

Load by land-river segment and land use

BMPs are applied which give, in aggregate, a 1/3 reduction

27 * (1-.33) = 18 lbs/acre

CAST Structure

Average Load

+

△ Inputs * Sensitivity

*

BMPs

*

Acres

*

Land to Water

*

River Delivery

Load by land-river segment and land use

There are 100 acres of double cropped land in this segment

18 lbs/acre * 100 acres = 1800 lbs

CAST Structure

Average Load

+

△ Inputs * Sensitivity

*

BMPs

*

Acres

*

Land to Water

*

River Delivery

The land here is 50% leaker than average due to high groundwater recharge in the piedmont carbonate

The river system reduces loads by 10%

1800 lbs * 1.5 * (1-.10) = 2430 lbs
Delivered to the Bay from this land use and segment

Load by land-river segment and land use

Sensitivities – all else being equal…

Phase 7 CAST

Double Cropped land

Average Load
=
△ Inputs * Sensitivity
*
BMPs
*
Acres
*
Land to Water
*
River Delivery
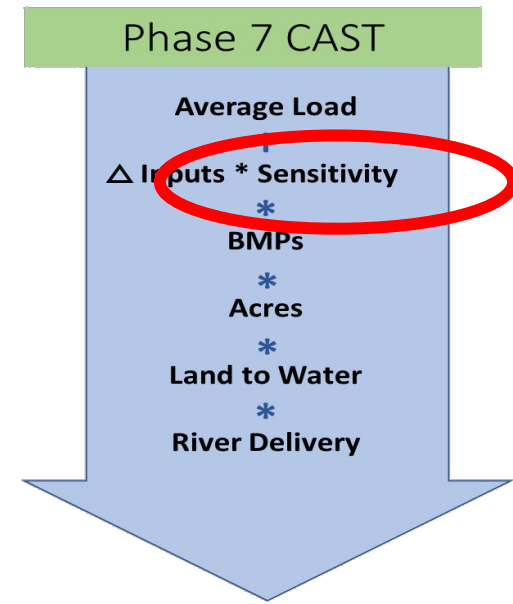
Change in output from 1 pound of input change - Nitrogen

P7 workplan: will investigate new sensitivities

NH3   OrgN   NO3

P Sensitivities

Average Load
=
△ Inputs * Sensitivity
*
BMPs
*
Acres
*
Land to Water
*
River Delivery
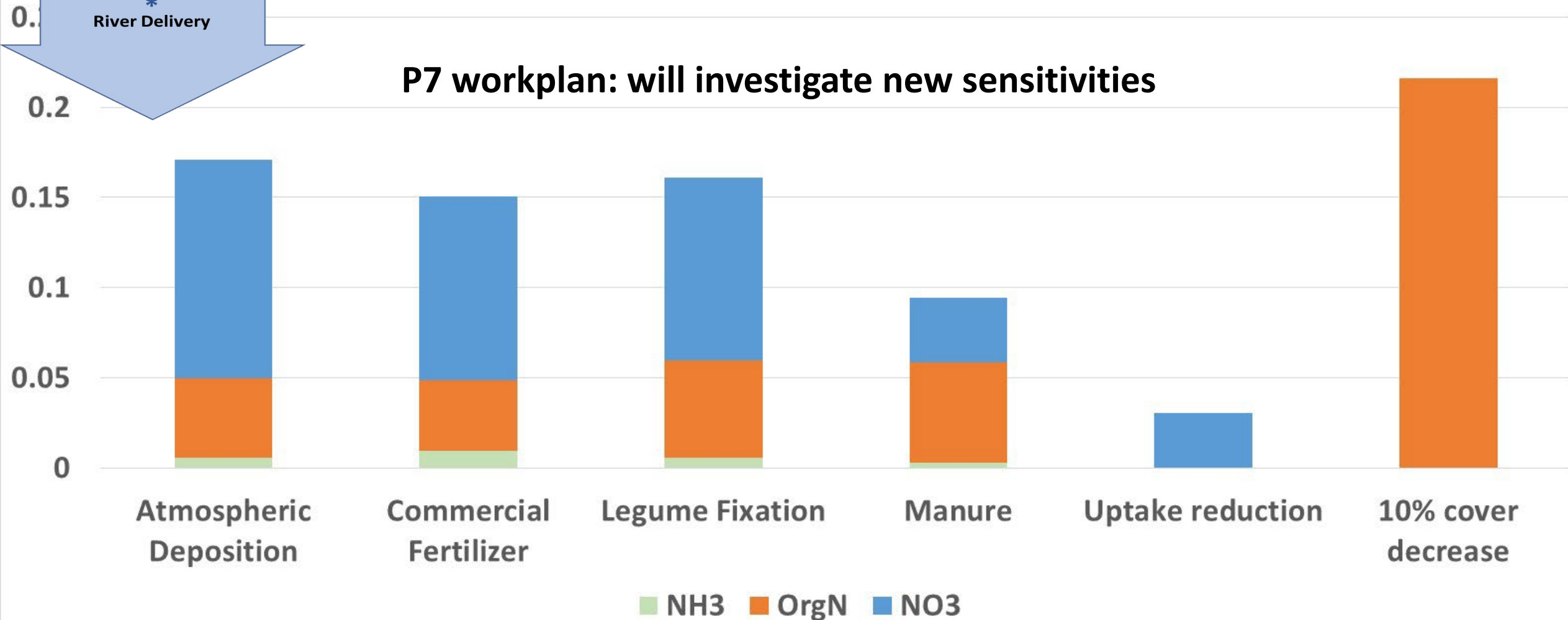
P6 workplan: will investigate new sensitivities

Input	Input Unit	Average Slope	Median Slope	Median S_R	Relative Sensitivity
Soil P	ppm	0.017	0.015	0.696	Moderately sensitive
Sediment Washoff	ton/ac	0.181	0.168	0.633	Moderately sensitive
Stormflow	Inches	0.064	0.057	0.403	Moderately sensitive
Water Extractable P	lbs/acre	0.021	0.018	0.187	Slightly sensitive

Consistency > Accuracy

Average Load
+
△ Inputs * Sensitivity
*
BMPs
*
Acres
*
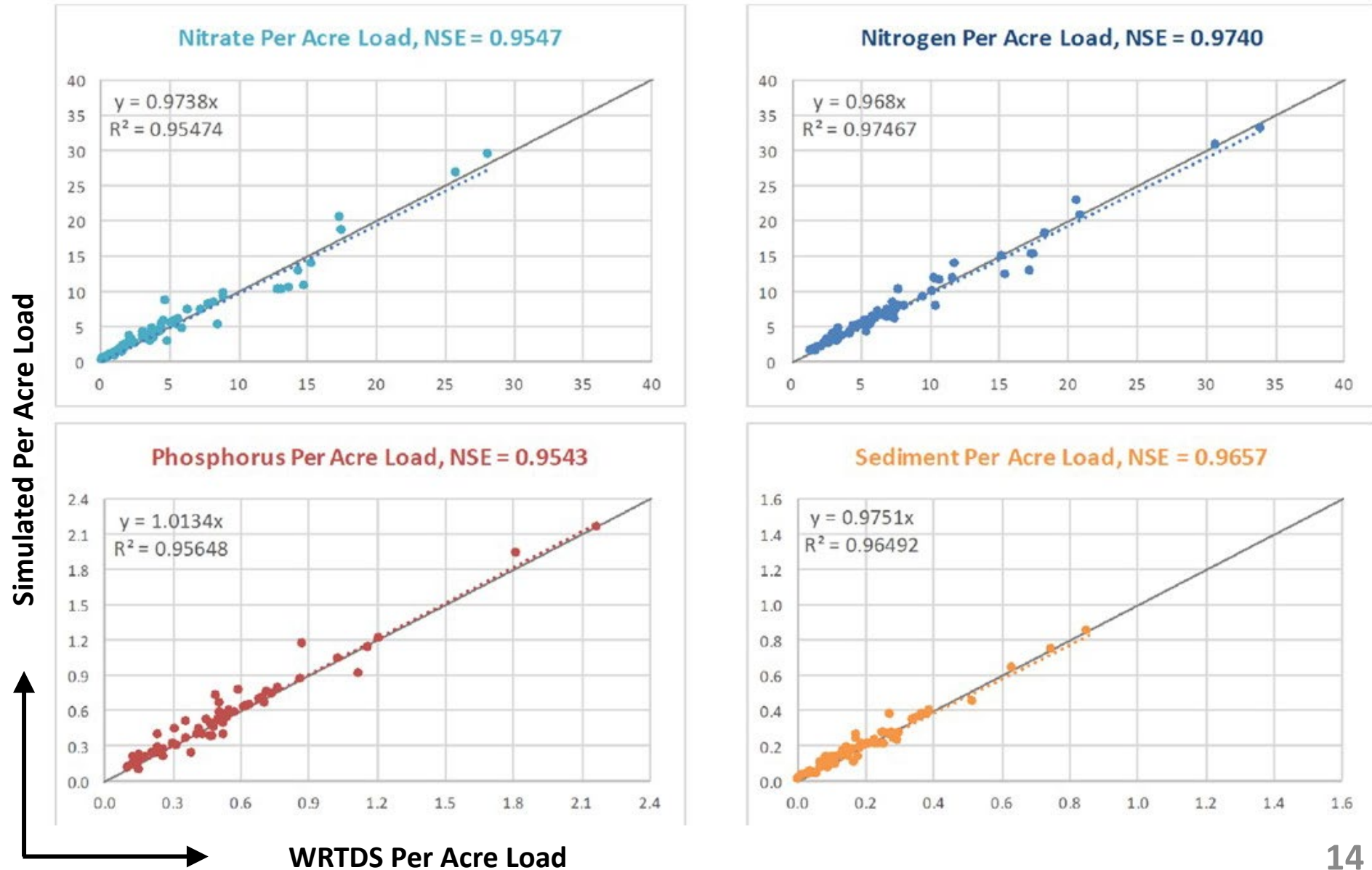Land to Water
*
River Delivery
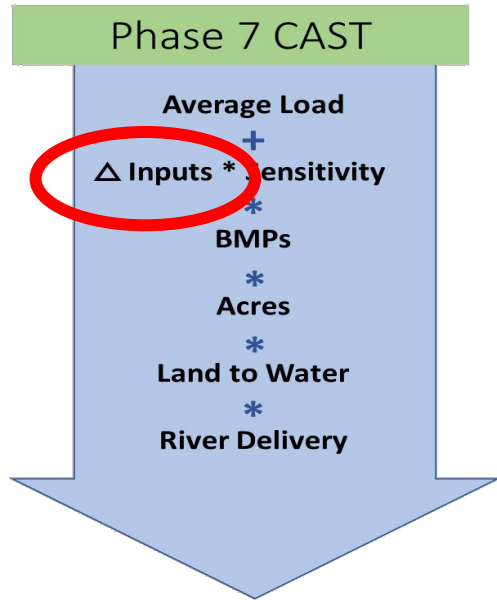
Accuracy of the spatial and temporal trends is more important that the absolute value

Spatial - Model used to allocate responsibility between jurisdictions

Temporal - Model used to track TMDL, based on changes since 1995

13

Phase 6 Geographic efficiencies

Model belief and useability (IMO)

- CBP modeling workgroup
  - Spatial accuracy of yields
  - Match concentration frequency distribution
  - Hydrology statistics
  - Were they involved in the development
- Stakeholders
  - Does it have their inputs?
    - Land use
    - Fertilizer use
    - Management actions
  - Were they involved in the development?
  - Does it act like they want it to?
- Real use is long-term anthropogenic change in load.

Chesapeake Bay TMDL Indicator (Non-Tidal Network Stations)

* This APP is designed for visualizing the monitored load trend and CAST-estimated load trend for the Chesapeake Bay Non-Tidal Network (NTN) stations.
* This APP contains data for 83, 66, and 66 stations for Total Nitrogen (TN), Total Phosphorus (TP), and Suspended Sediment (SS), respectively.
* This APP is frequently updated based on comments and suggestions received from the Chesapeake Bay Program partnership.
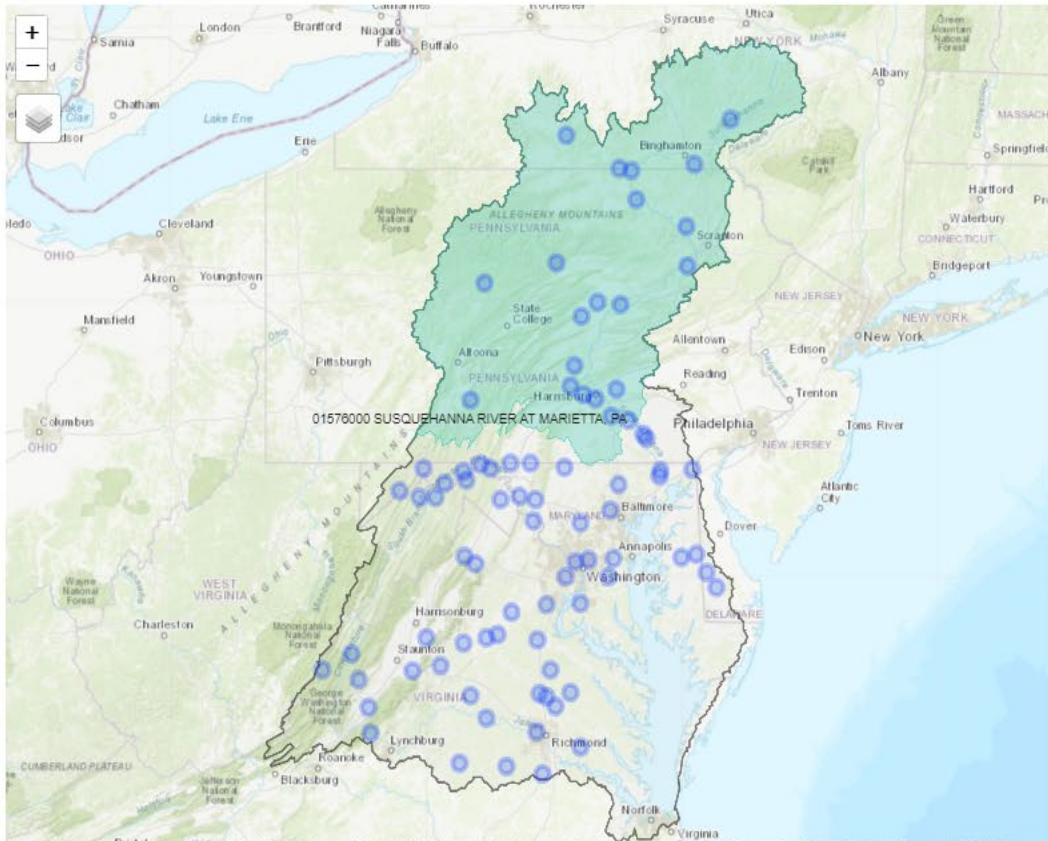
Step 1: Select the water-quality parameter:

⦿ Total Nitrogen ◯ Total Phosphorus ◯ Suspended Sediment

Step 2: Select the monitoring station by clicking either Map or Table:

| Map | Data Table |

Tip: Move mouse cursor to any circle marker to show the station name.

01576000 SUSQUEHANNA RIVER AT MARIETTA, PA

Leaflet | Tiles © Esri — Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community
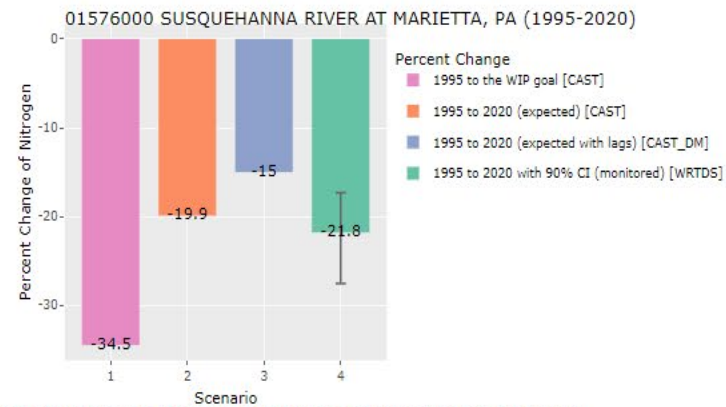
About   Timeseries   WIP Goal   Progress   Download

Interactive Plot

01576000 SUSQUEHANNA RIVER AT MARIETTA, PA (1995-2020)

Percent Change

- 1995 to the WIP goal [CAST]
- 1995 to 2020 (expected) [CAST]
- 1995 to 2020 (expected with lags) [CAST_DM]
- 1995 to 2020 with 90% CI (monitored) [WRTDS]

Bar 1: -34.5
Bar 2: -19.9
Bar 3: -15
Bar 4: -21.8

Y-axis: Percent Change of Nitrogen
X-axis: Scenario

(Note 1: Negative values indicate load reductions; positive values indicate load increases.)

(Note 2: To obtain values in million pounds (Mlbs), multiply the percent change shown in this plot by the CAST load in the first year of the assessment period, which is available in the Data Table under the About tab.)

Data Type

WRTDS: Monitored load - computed using the USGS WRTDS flow-normalization method (source).

CAST: Expected load in the long term - computed using the Chesapeake Bay Program Watershed Model (source).

CAST_DM: Expected load with lags - computed using the Chesapeake Bay Program Watershed Model (source).

Interpretive Text

For Nitrogen at 01576000 SUSQUEHANNA RIVER AT MARIETTA, PA, the period of analysis is 1995-2020.

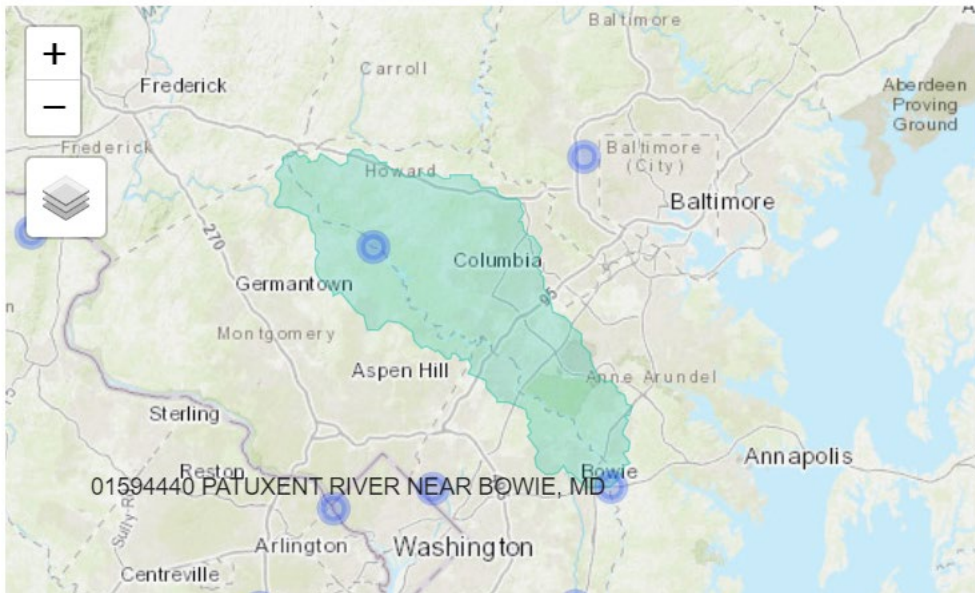1. Overall reduction - comparing the baseline year of 1995 with the WIP goal:
[Bar 1] A reduction of 34.5 percent is required to meet the WIP goal, as estimated by CAST.

2. Current progress - comparing the baseline year of 1995 with the current year of 2020:
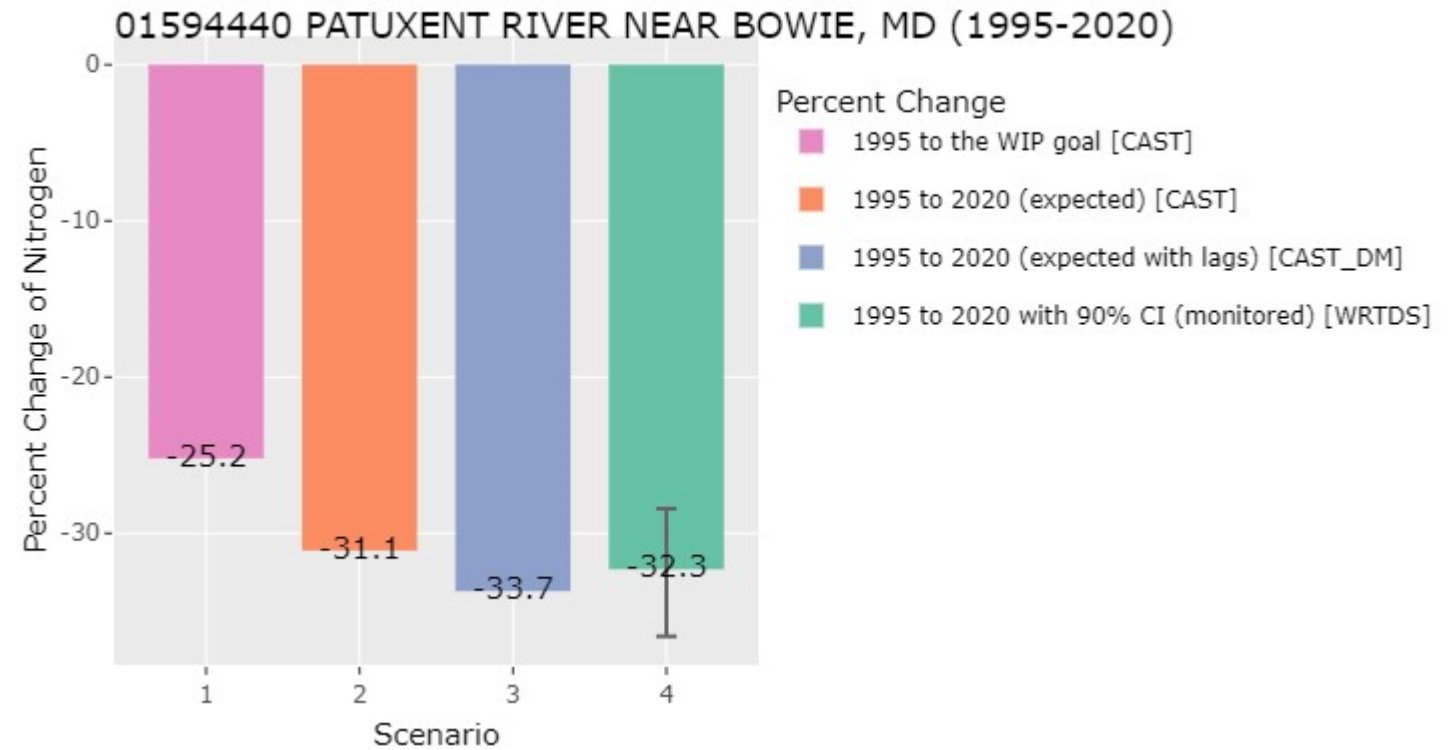[Bar 2]: A reduction of 19.9 percent is estimated by CAST; this is the eventual (long-term) trend under the 2020 conditions of sources, implementations, and land uses.
[Bar 3]: A reduction of 15 percent is estimated by CAST_DM; this is the expected trend with lags and other factors.
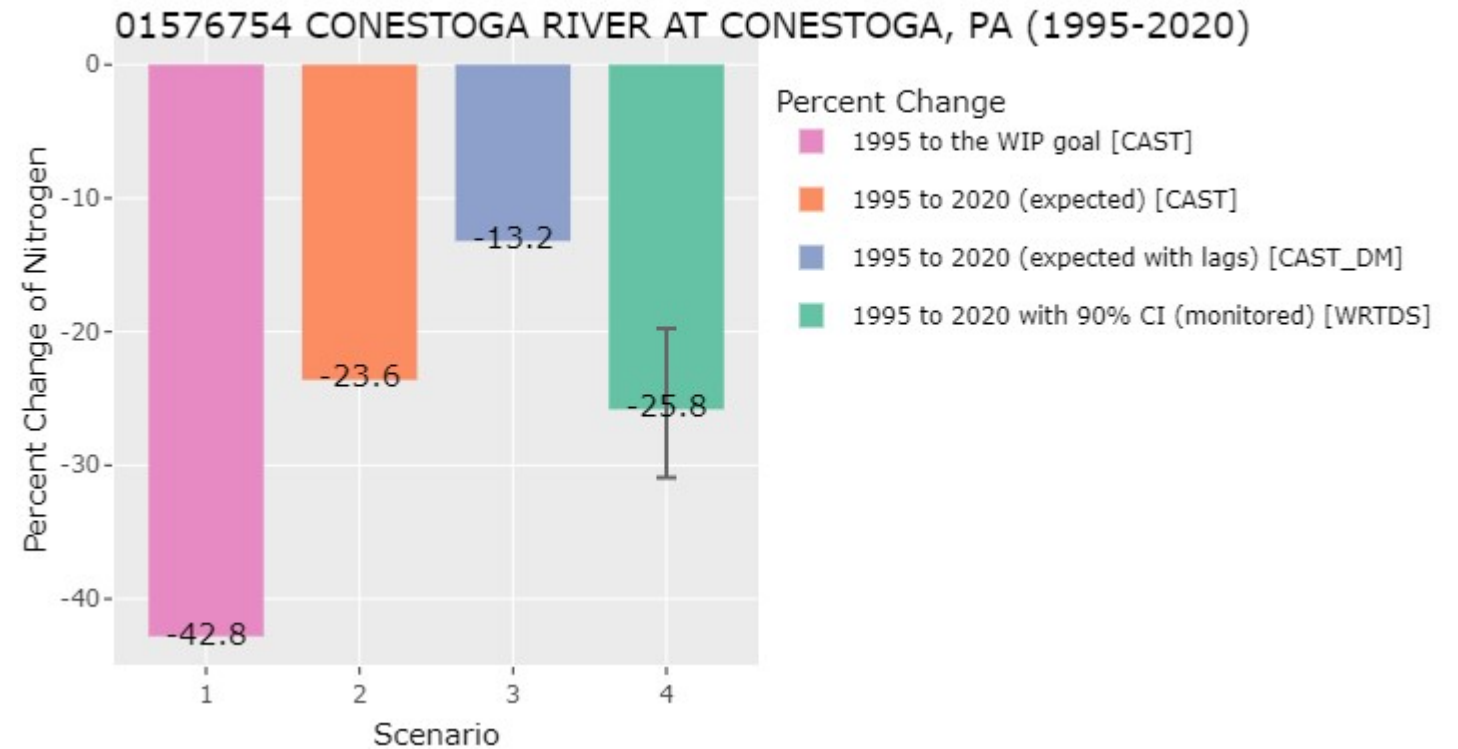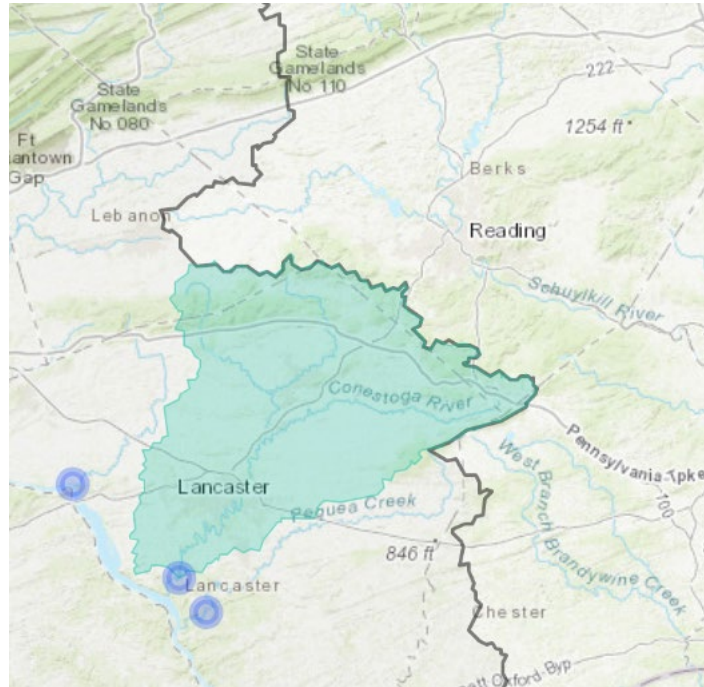[Bar 4]: A reduction of 21.8 percent is estimated by WRTDS; this is the observed trend based on the monitoring data. The estimated 90% confidence interval for this trend is (-27.6%, -17.3%).
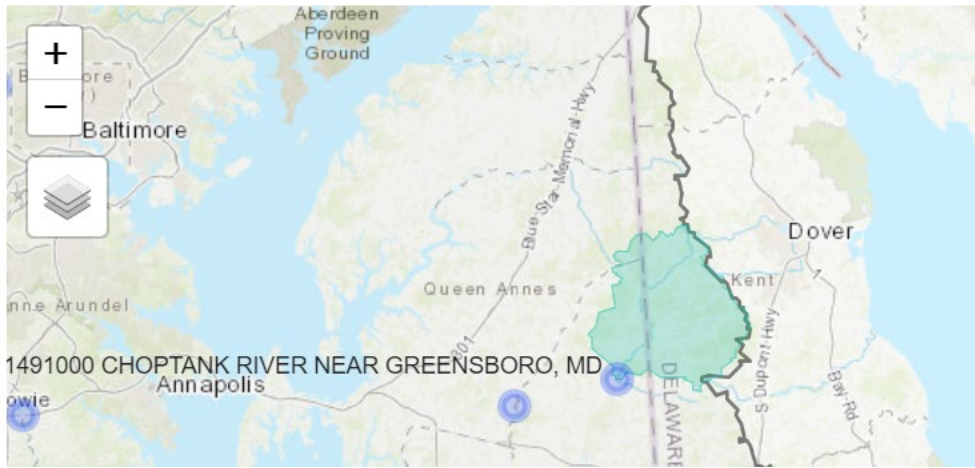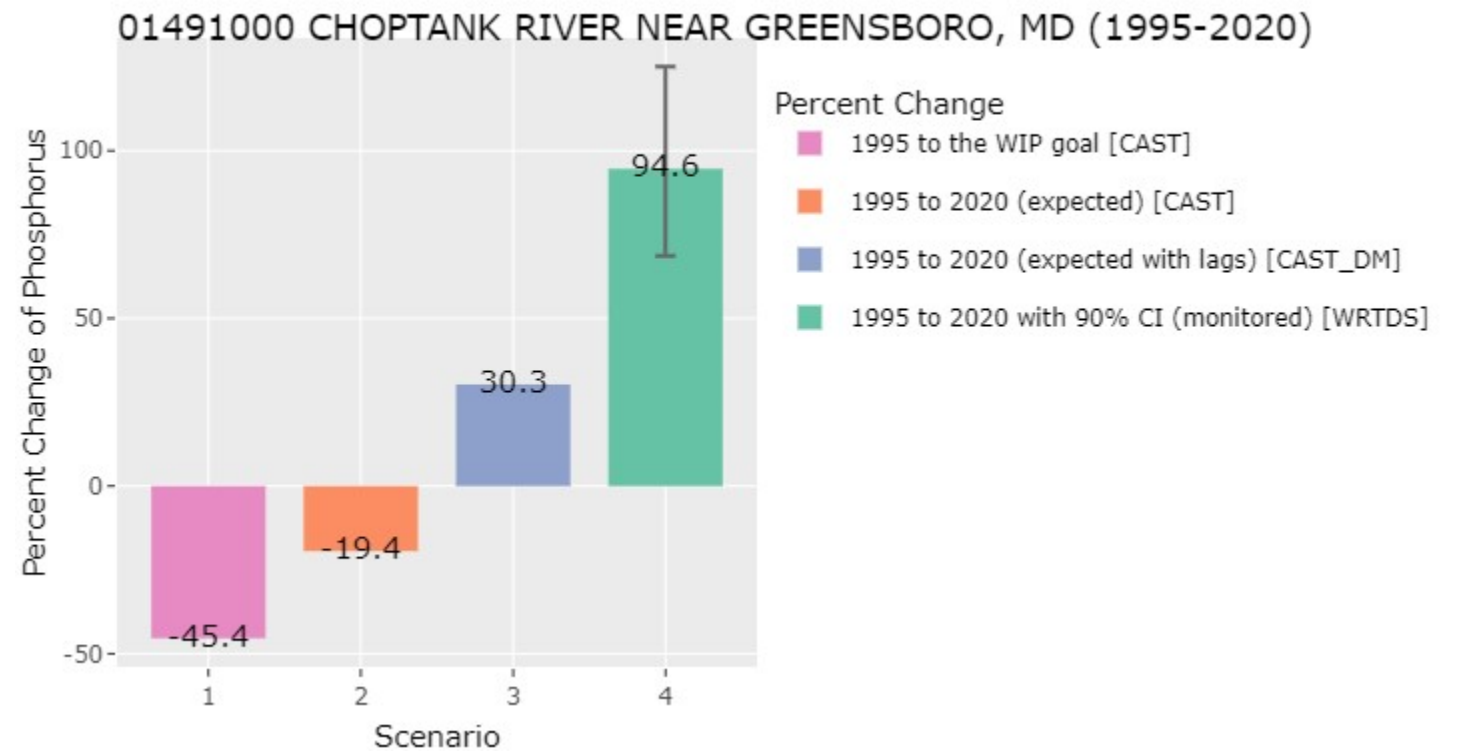
Nitrogen in the Patuxent

01594440 PATUXENT RIVER NEAR BOWIE, MD

01594440 PATUXENT RIVER NEAR BOWIE, MD (1995-2020)

Percent Change

- 1995 to the WIP goal [CAST]
- 1995 to 2020 (expected) [CAST]
- 1995 to 2020 (expected with lags) [CAST_DM]
- 1995 to 2020 with 90% CI (monitored) [WRTDS]

-25.2
-31.1
-33.7
-32.3

https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

Nitrogen in the Conestoga

Phosphorus in the Choptank

01491000 CHOPTANK RIVER NEAR GREENSBORO, MD (1995-2020)

Percent Change

- 1995 to the WIP goal [CAST]
- 1995 to 2020 (expected) [CAST]
- 1995 to 2020 (expected with lags) [CAST_DM]
- 1995 to 2020 with 90% CI (monitored) [WRTDS]

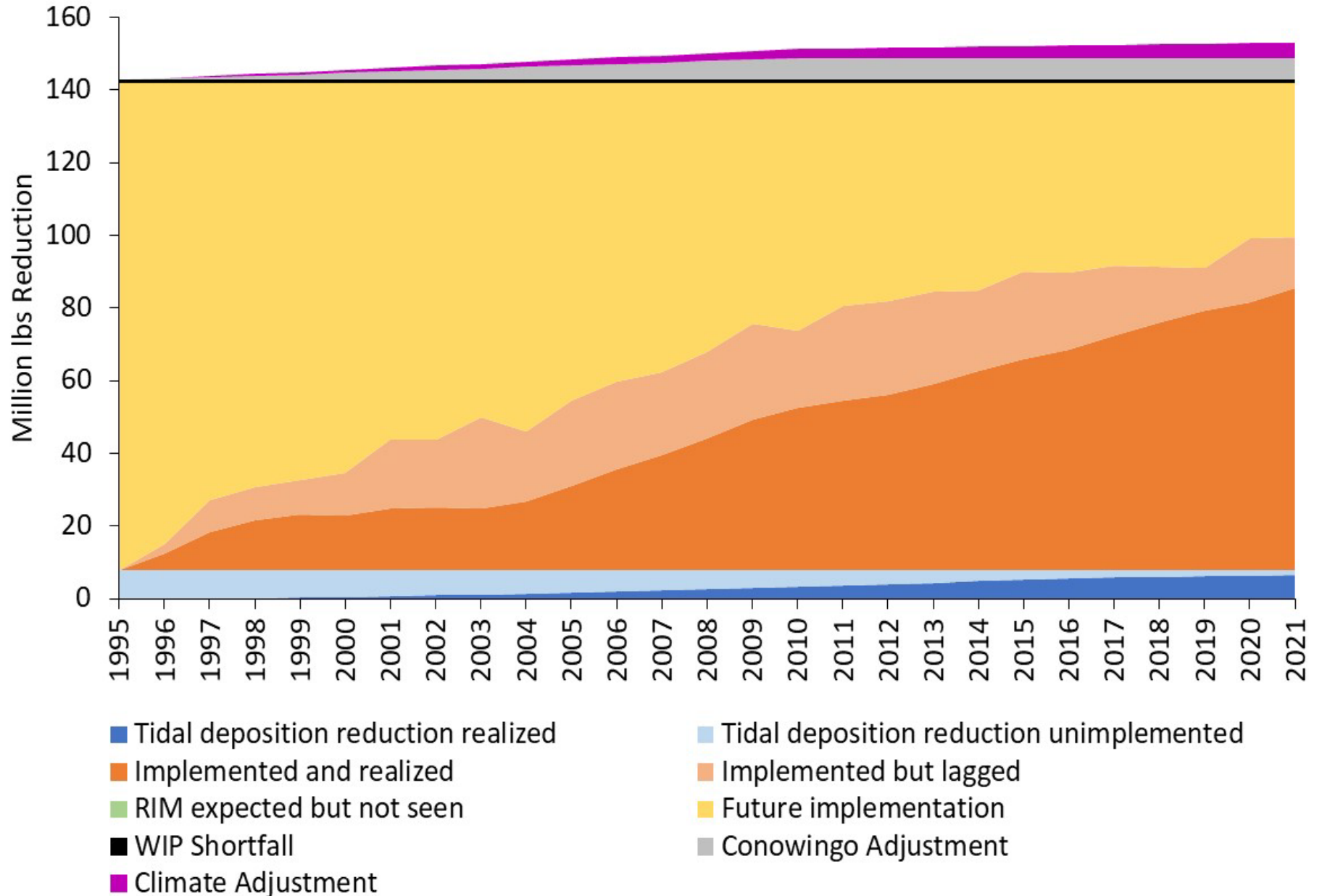# Public Indicator

Updated Annually

Chesapeake Bay TMDL Load Indicator
Total Nitrogen

Web team will reformat
Including addressing
accessibility

Chesapeake Bay TMDL Load Indicator
Total Phosphorus

Public Indicator

Updated Annually

Web team will reformat
Including addressing
accessibility