

Integrated Watershed TMDL Indicator and Dashboard Products

Qian Zhang, Gopal Bhatt, Isabella Bertani, and other CBPO staff

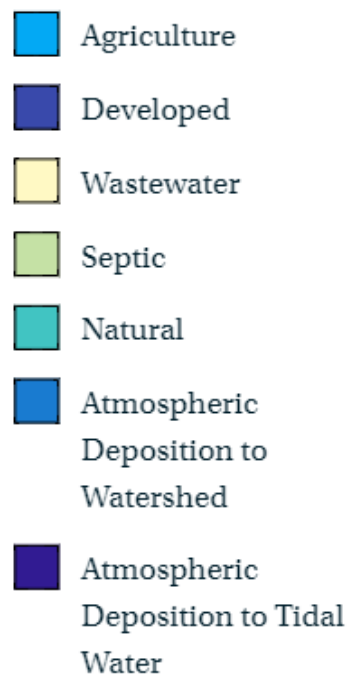
WQGIT
03/27/2022

Purpose of presentation

- Decision on Integrated Watershed-Wide Indicator
 - TMDL-required Reduction of N and P separated into:
 - Implemented and realized
 - Implemented but lagged
 - Future Implementation
 - + other smaller categories
- Discussion of station-level dashboard product
 - Compares expectations to monitored trends

WIP Indicator

We've almost hit the target level of implementation?



Modeled Nitrogen Loads to the Chesapeake Bay (1985-2021)

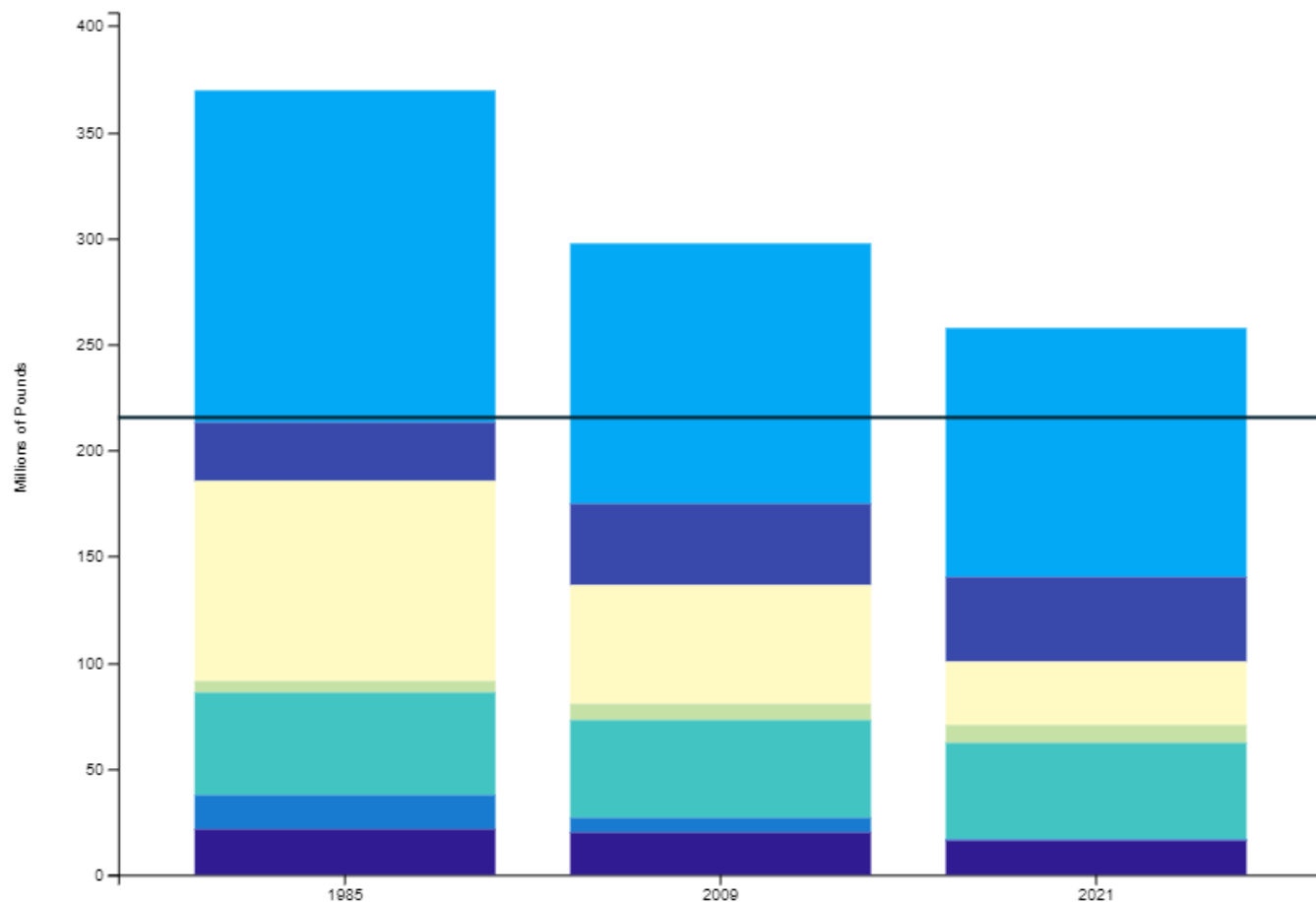
Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector wetlands which are preferable land use types with the lowest loading rates among sources.

[VIEW CHART](#)

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Loads by Source

Loads by Jurisdiction



Pollution Loads and River Flow to the Chesapeake Bay (1990-2019)

River and Watershed Input of Pollution Loads

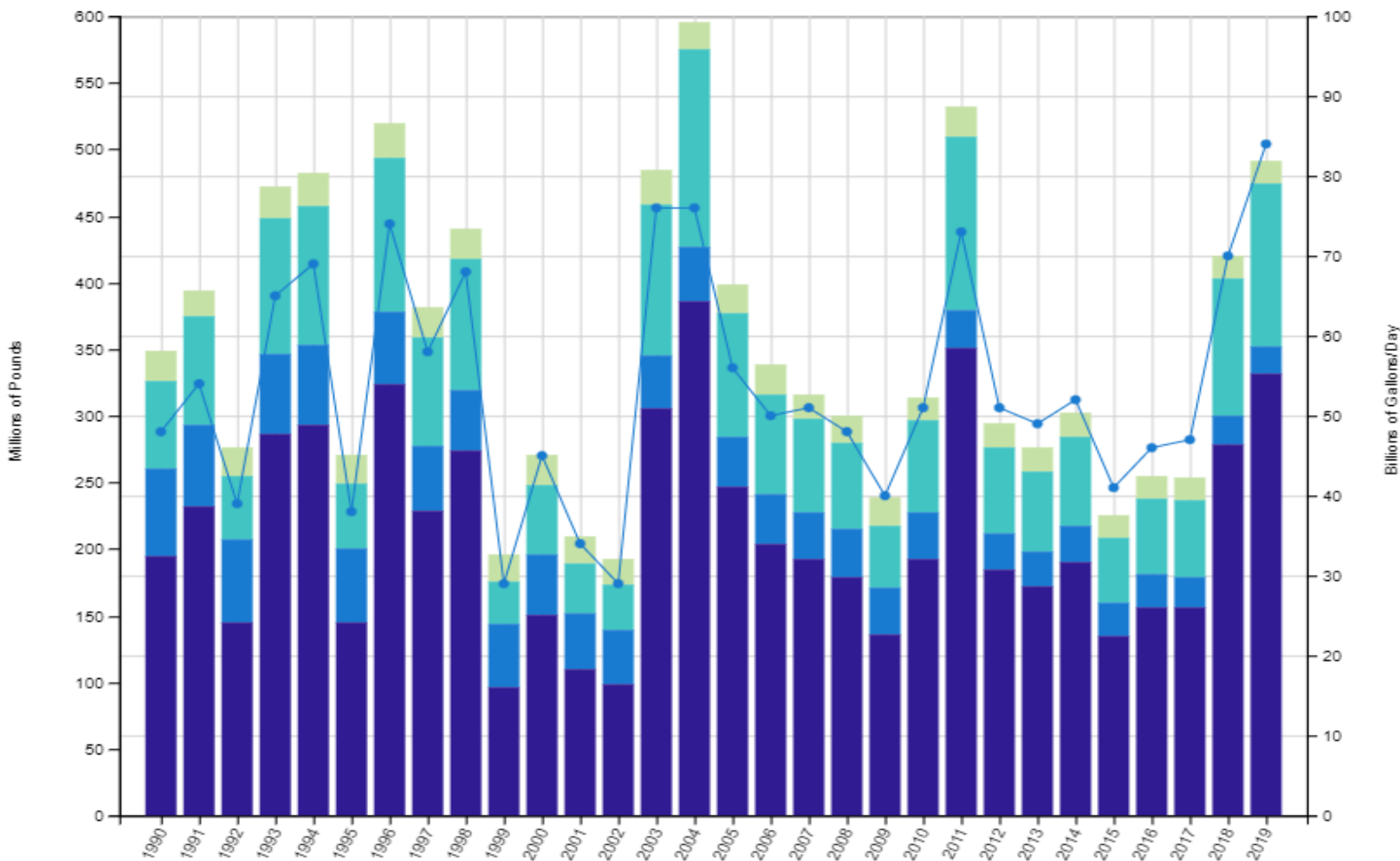
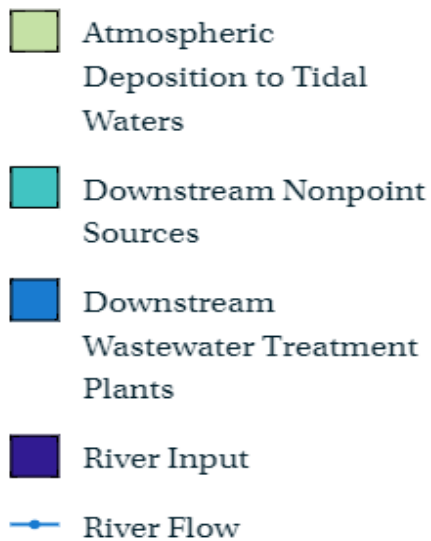
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Nitrogen Loads

Phosphorus Loads

Sediment Loads



Nontidal Load Indicator

Extreme variability
No Clear Trend

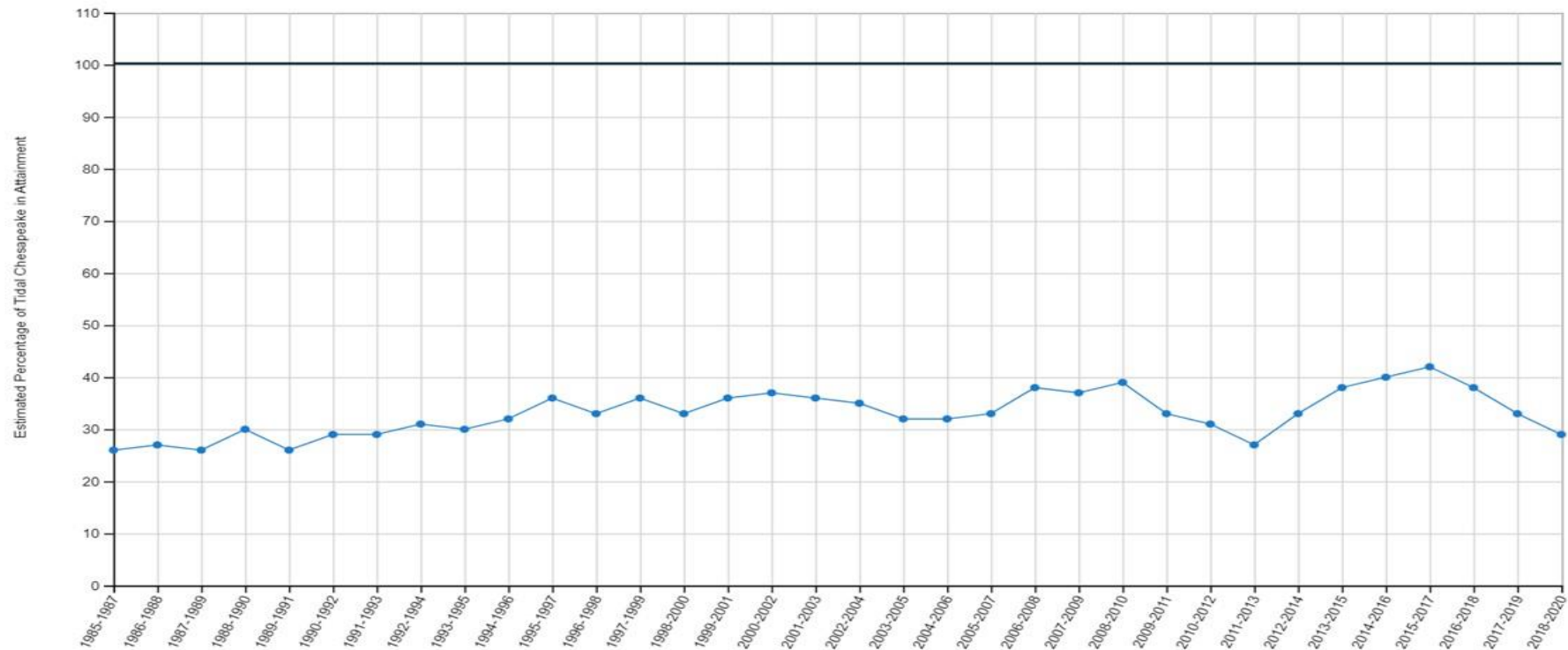
Tidal Water TMDL Indicator

Very slow
positive change

Water Quality Standards Attainment (1985-2020) ▲

Water quality is evaluated using three parameters: dissolved oxygen, water clarity or underwater grass abundance, and chlorophyll a (a measure of algae growth).

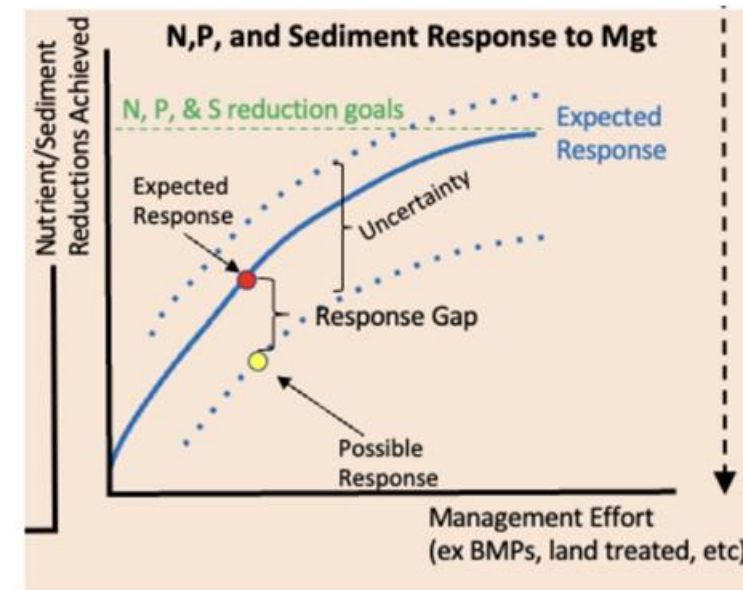
[VIEW CHART](#) [VIEW TABLE](#)



STAC Comprehensive Evaluation of System Response Report

Watershed Framing Questions

- Is the physical and social system responding to management efforts to meet TMDL N, P, and S goals in ways consistent with expectations?
- What are the major uncertainties in efforts to reduce N, P, and S stressors delivered to the Chesapeake Bay?
- What management actions/policy options could improve nutrient/sediment response or reduce response uncertainties? (see implications)



- Presented to WQGIT 10/26/2021
- https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/cesrtowqgit10-26-2021_final.pdf

Purpose: Build an indicator that is:

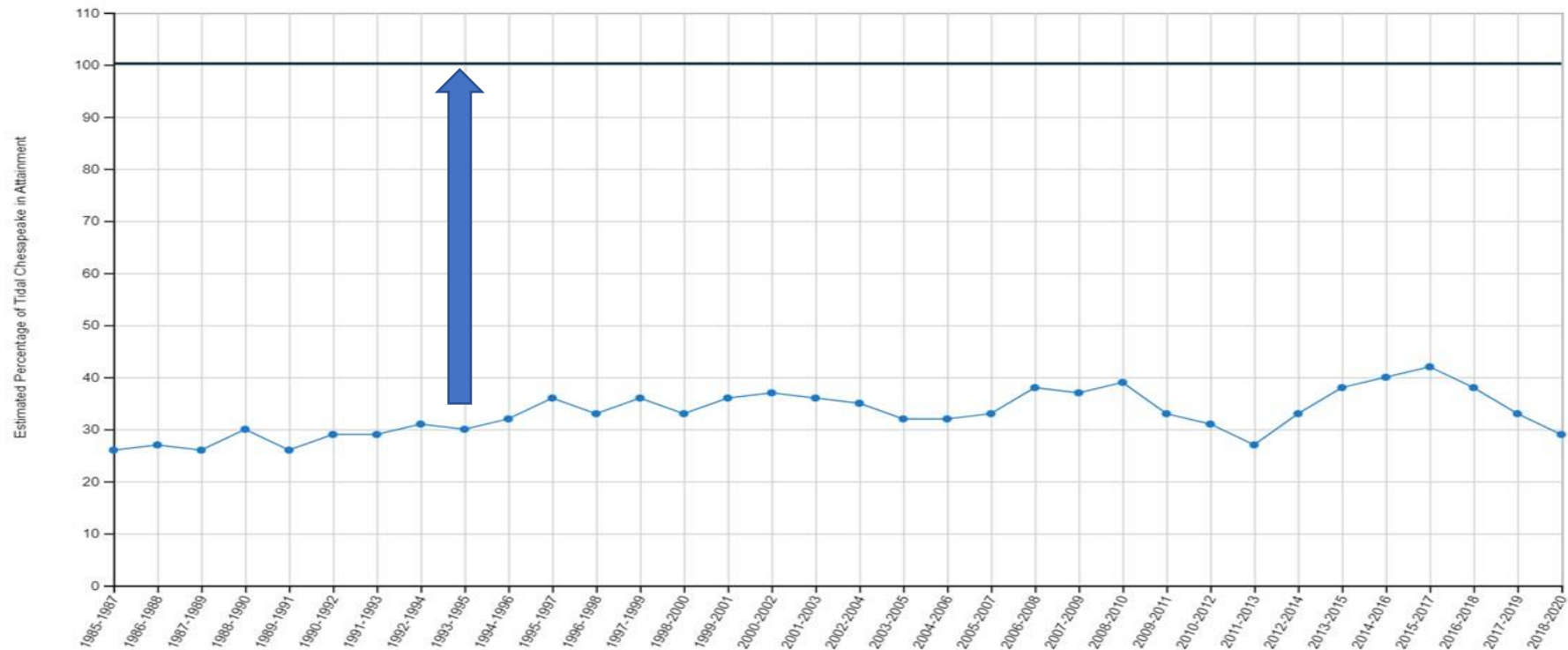
- Relevant to the TMDL
- Based on monitored changes in load to the extent possible
- Bridges monitoring and modeling by assessing lag time and other effects

TMDL question: What level of **load reduction from 1995** will be necessary to meet water quality standards?

Water Quality Standards Attainment (1985-2020) ▾

Water quality is evaluated using three parameters: dissolved oxygen, water clarity or underwater grass abundance, and chlorophyll a (a measure of algae growth).

[VIEW CHART](#) [VIEW TABLE](#)

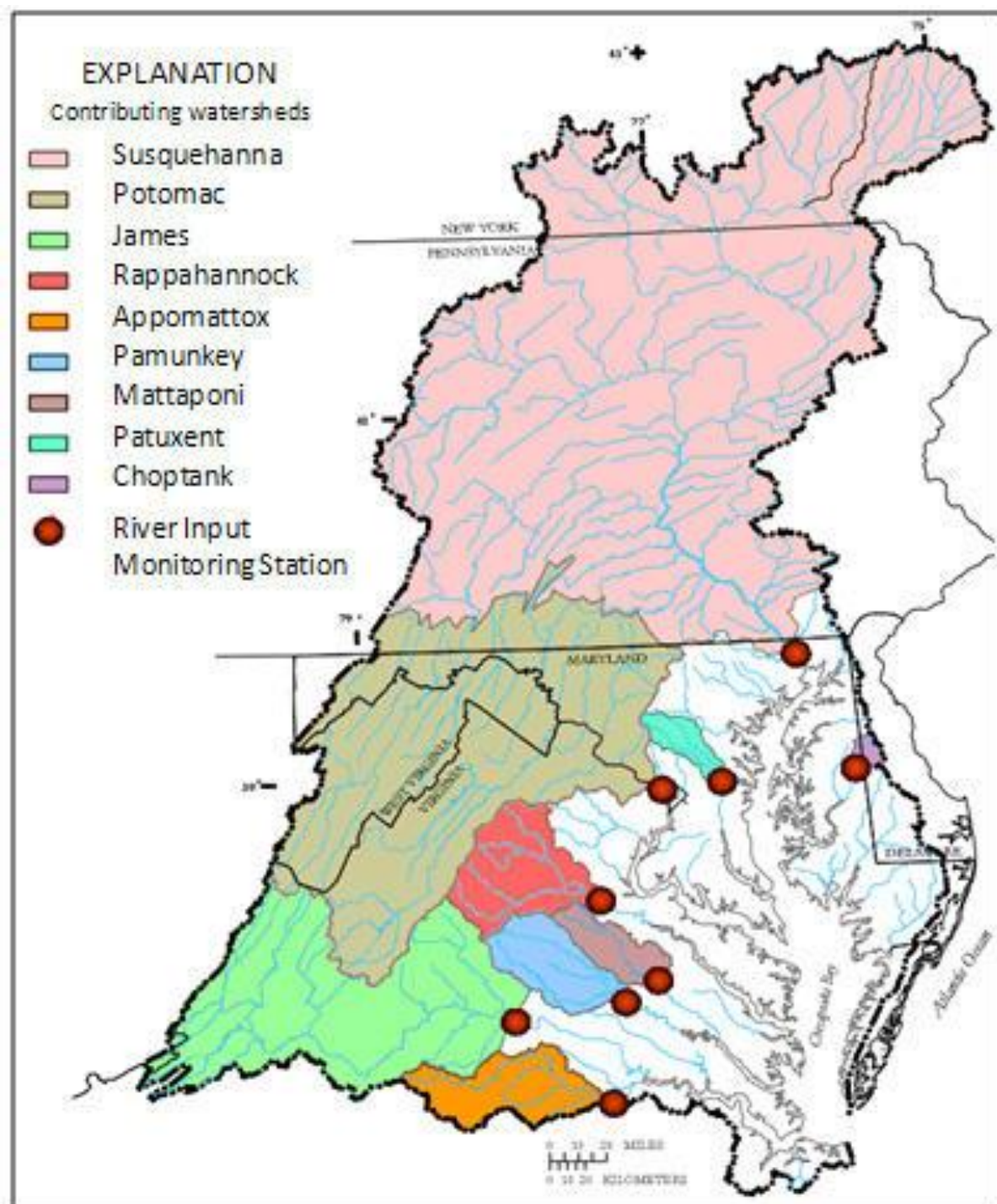


Loads required to meet TMDL Goals

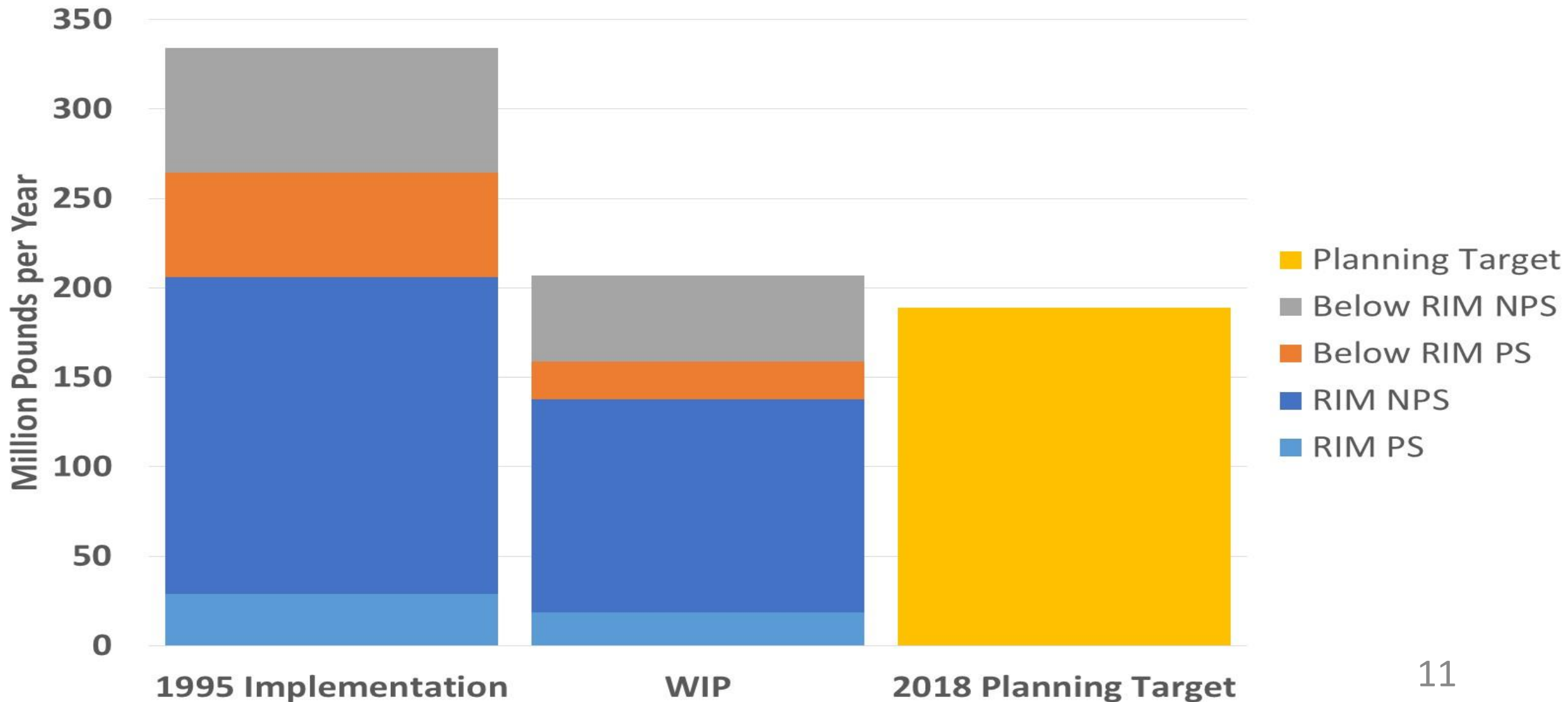


River Input Monitoring (RIM)

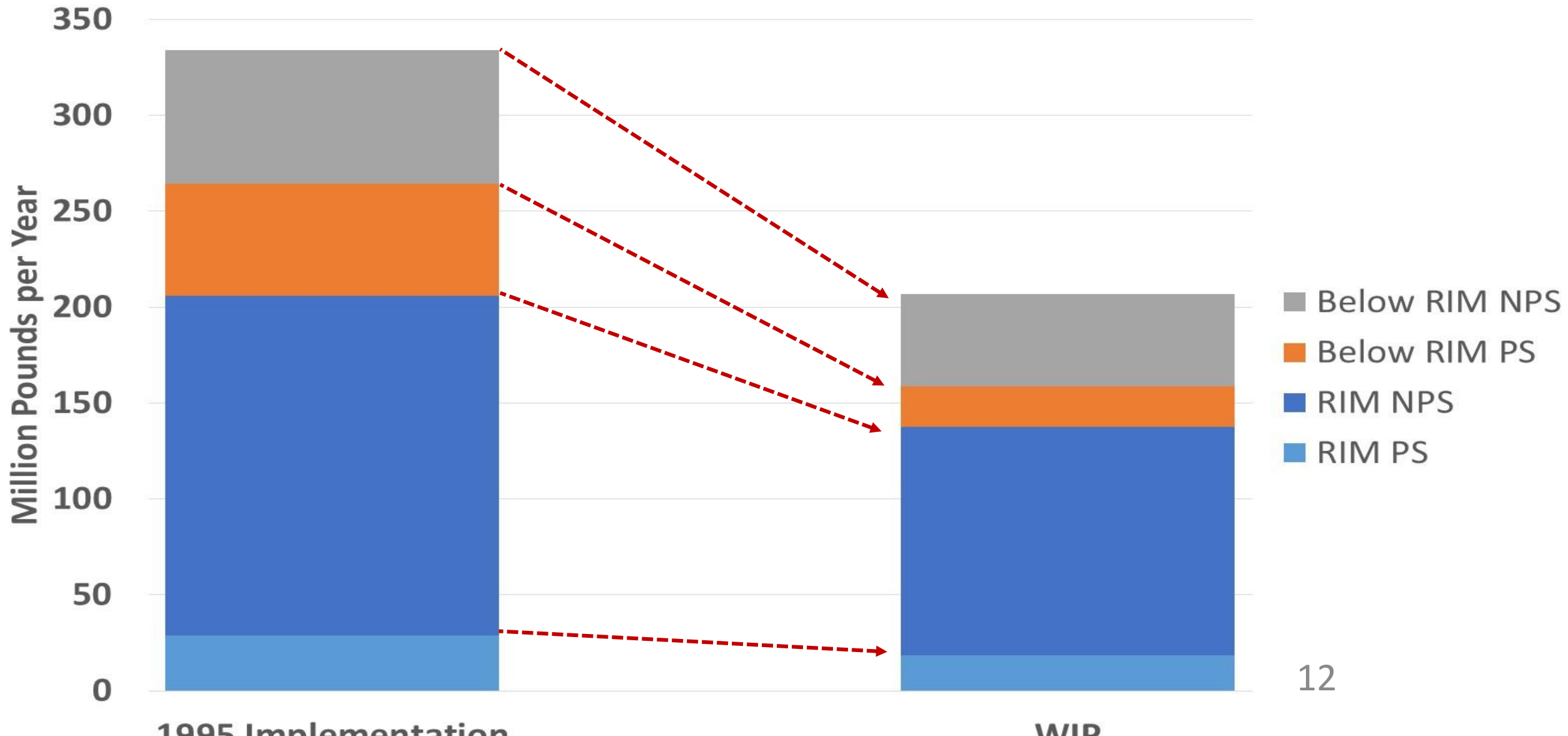
- Covers most of the CB watershed
 - 80% of land
 - 60% of load
- Many large WWTP are below RIM stations

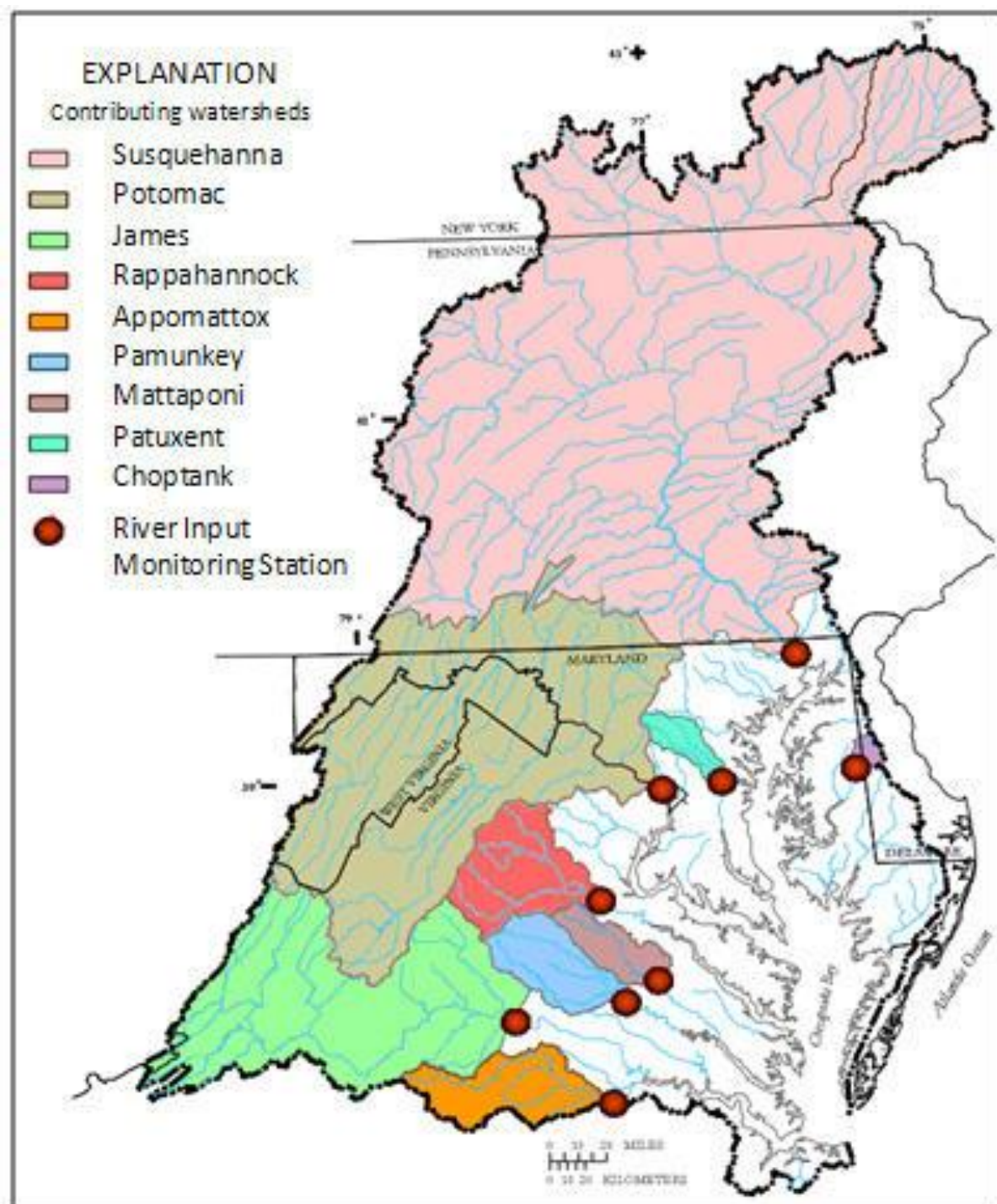


Reductions required to meet TMDL Goals

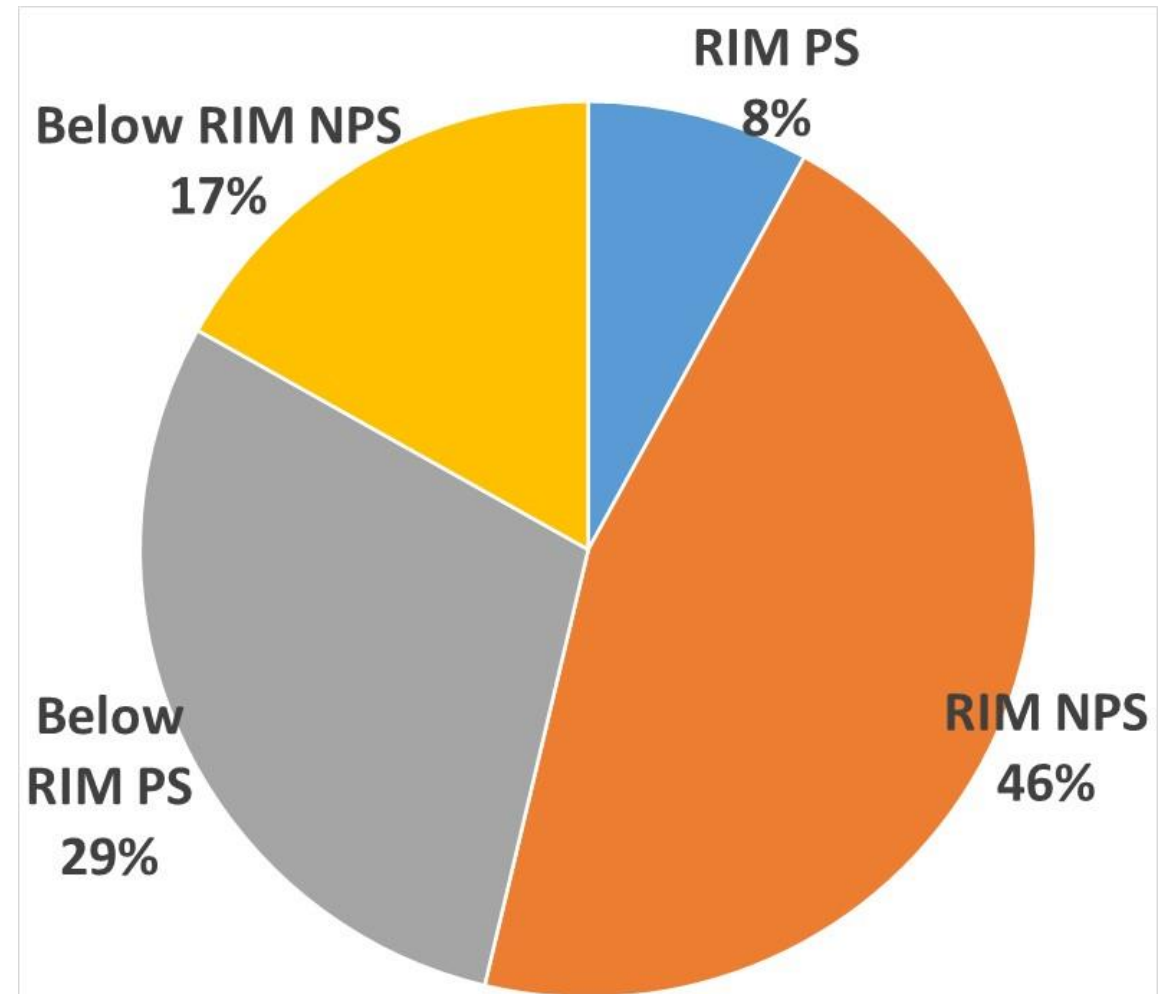


Reductions required to meet TMDL Goals

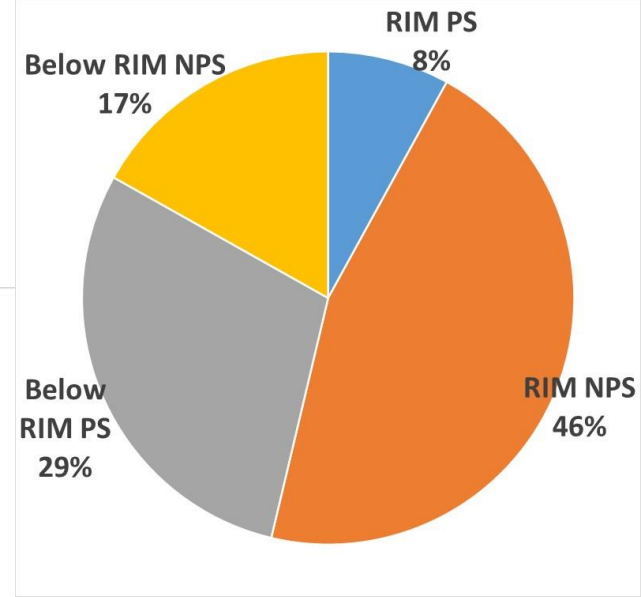
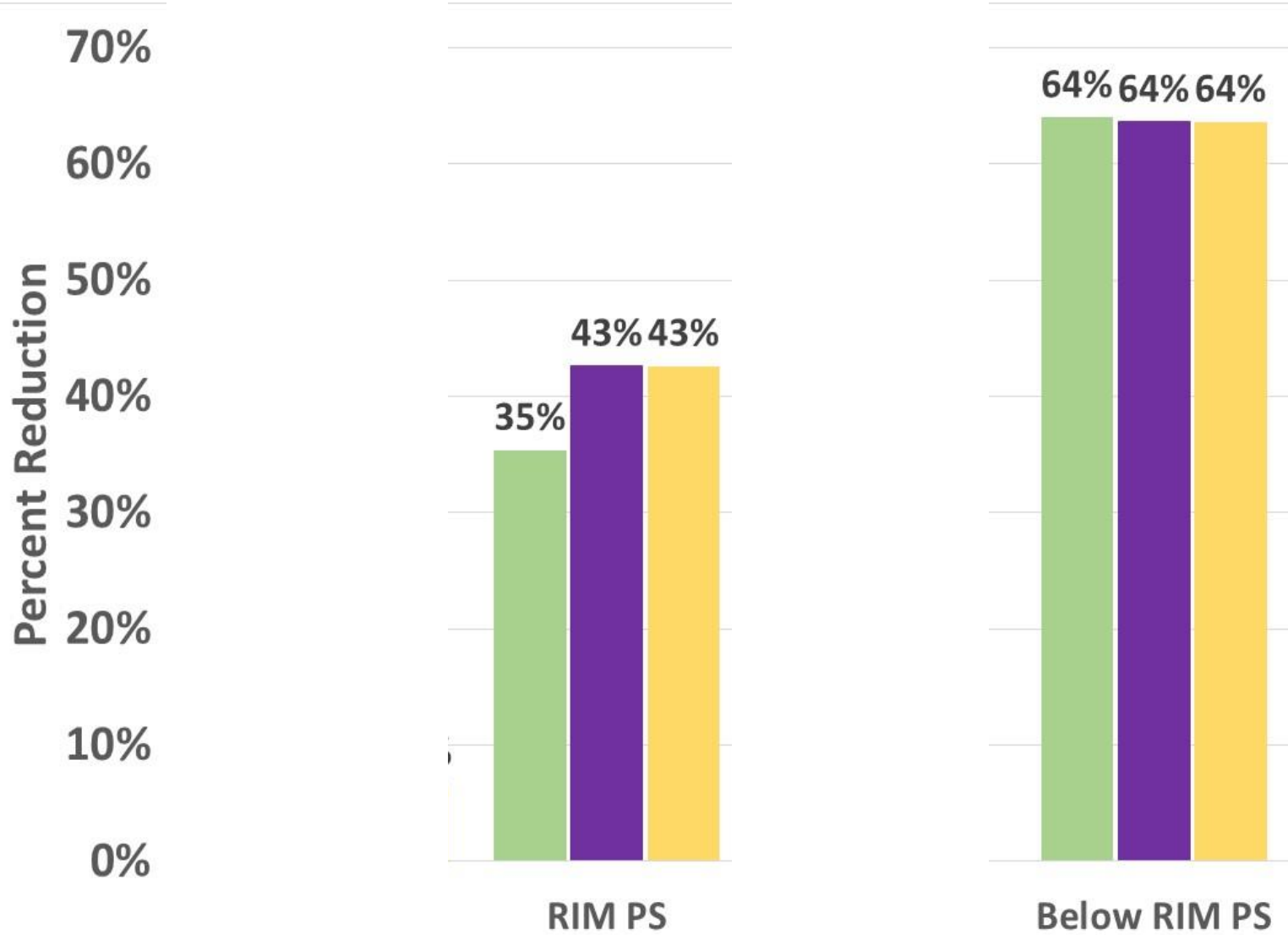




83% of Expected Reduction is Monitored

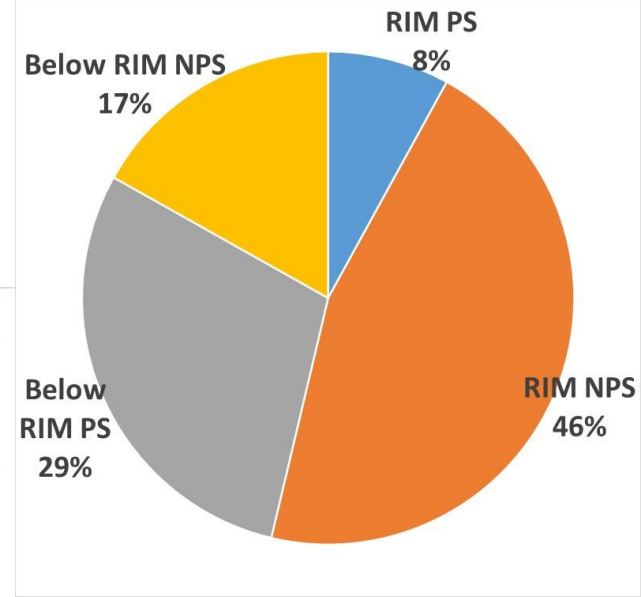
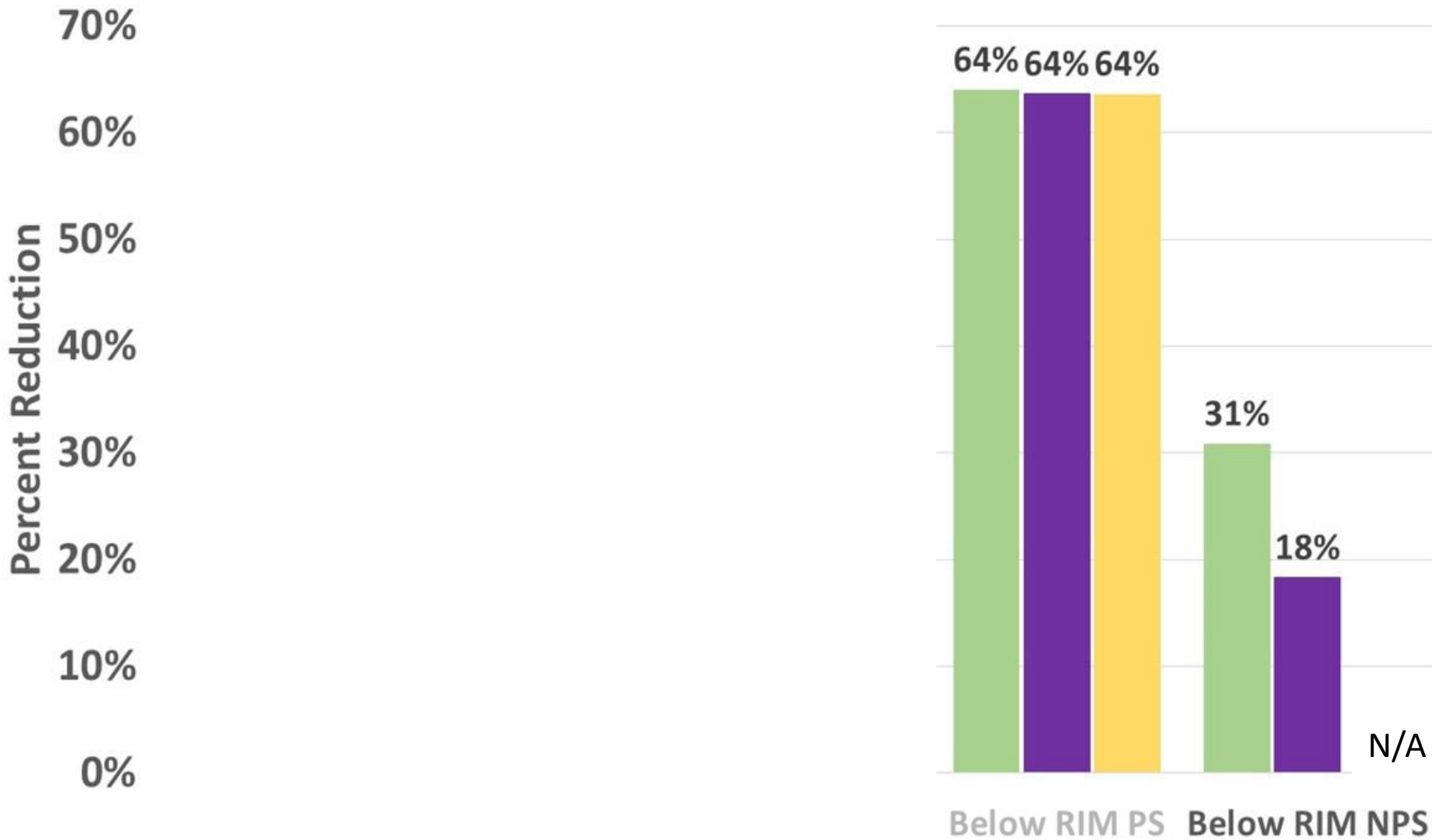


Wastewater is easy to measure and successful



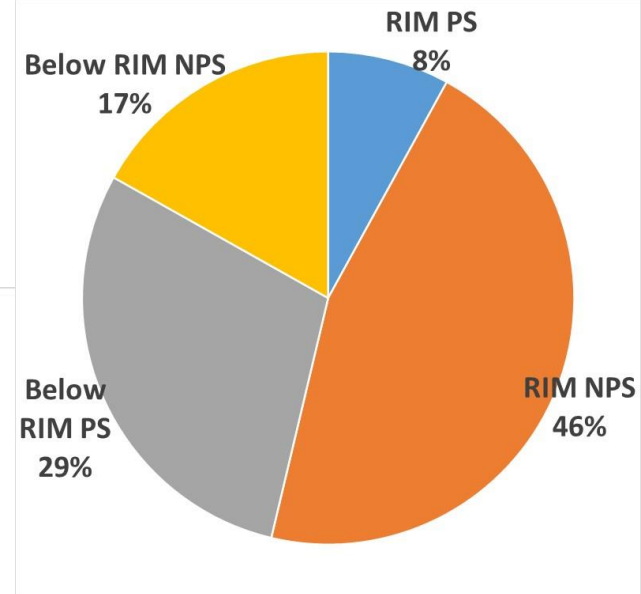
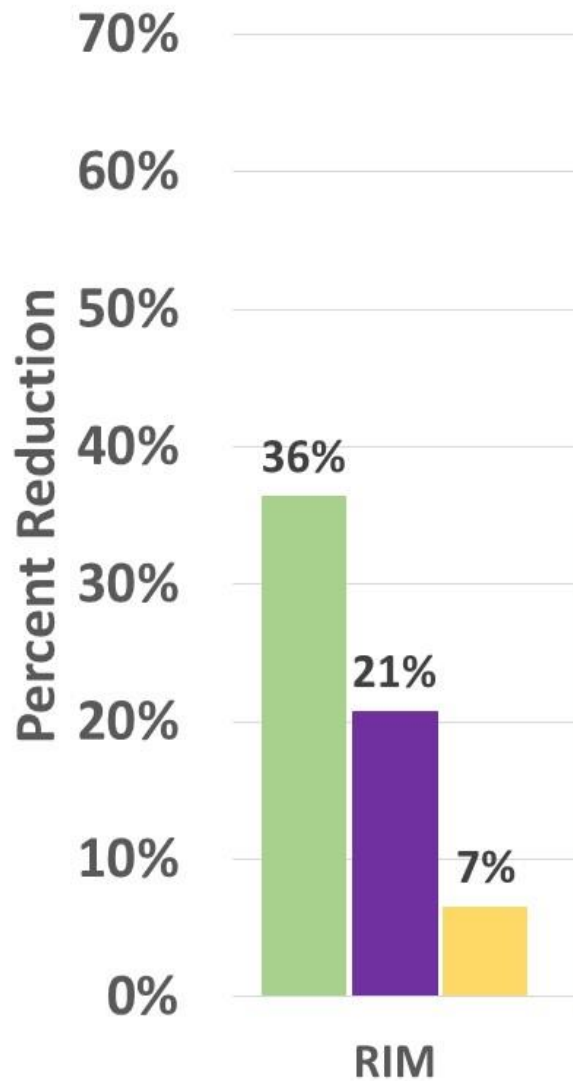
- Percent reduction to WIP (with Conowingo WIP)
- Expected reduction to 2021
- Monitored reduction to 2021

Below RIM NPS is about half implemented and is not fully monitored



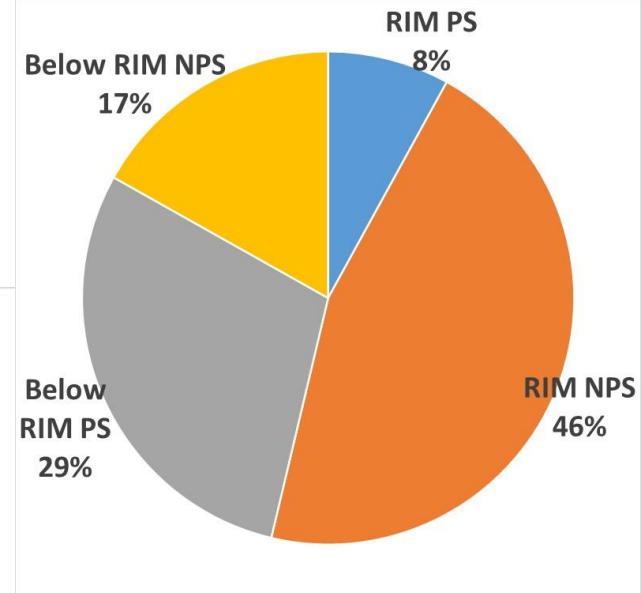
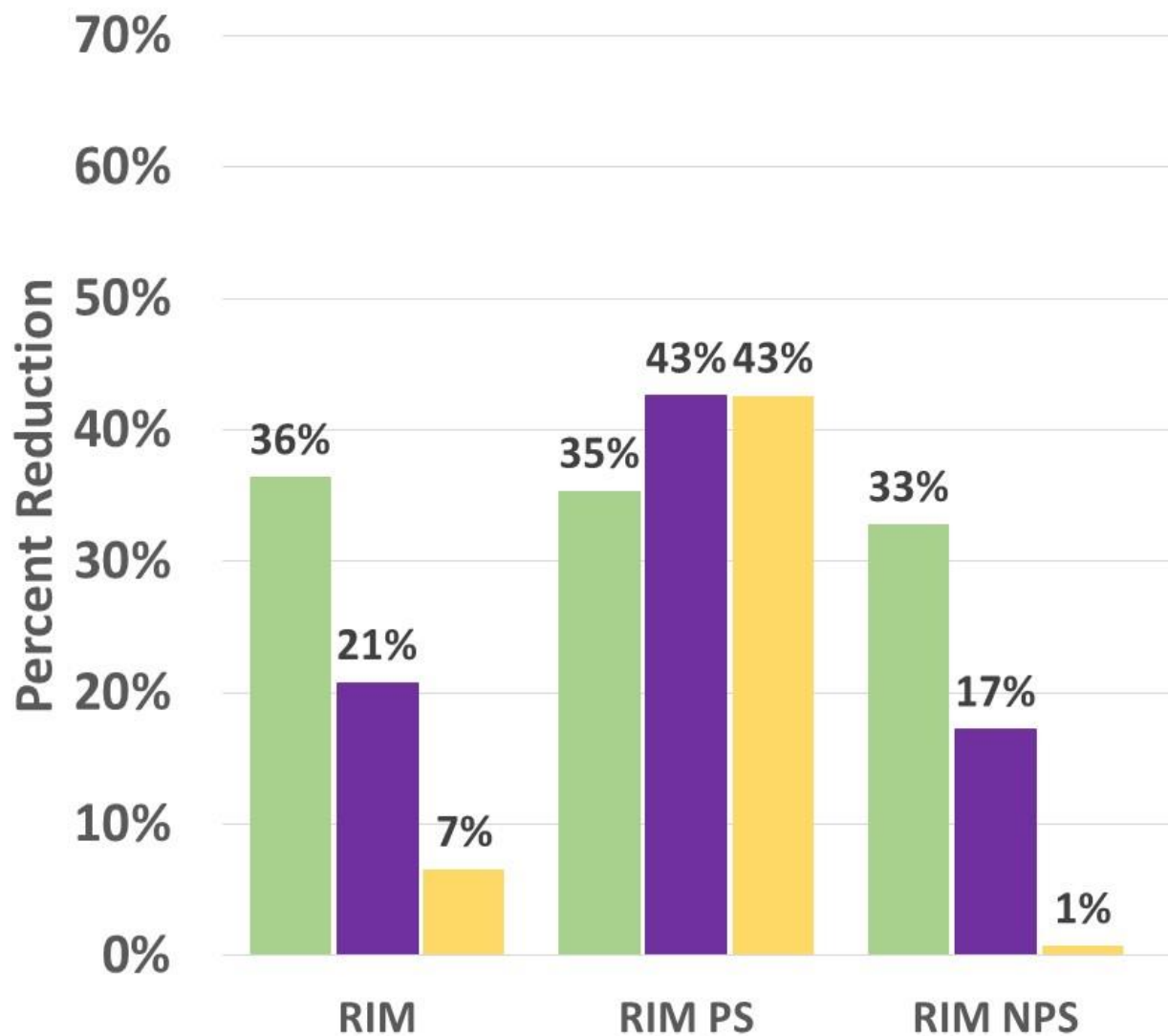
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Above RIM is about half implemented, but monitoring shows only a small reduction



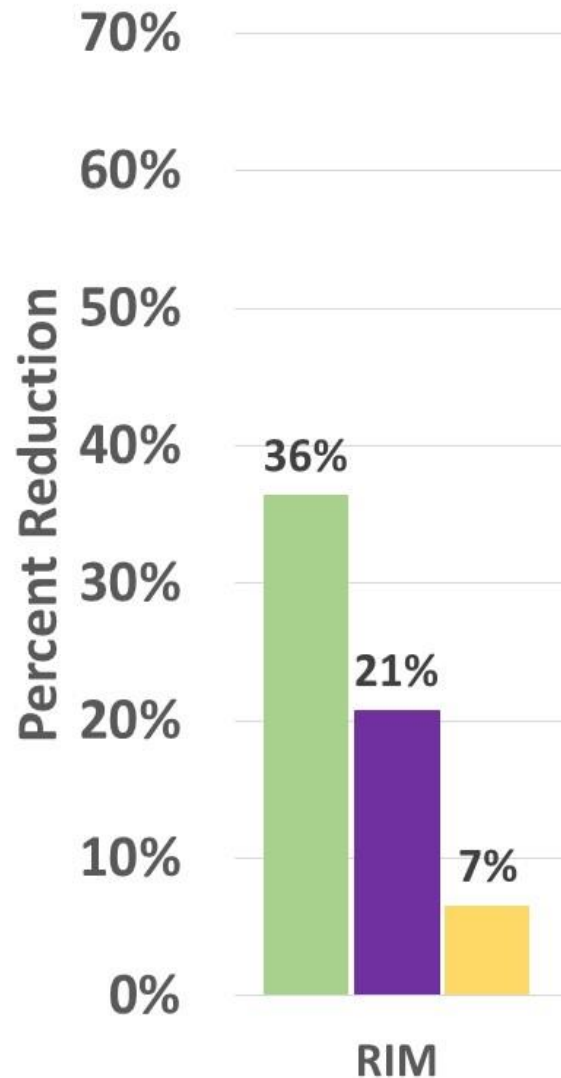
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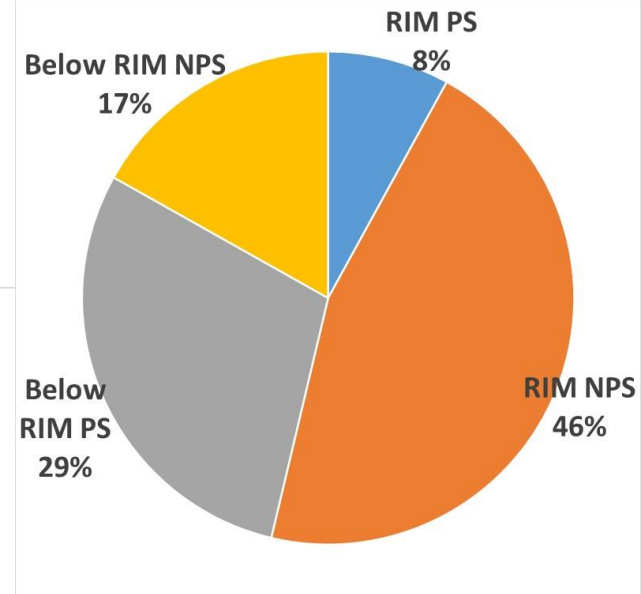
- Percent reduction to WIP (with Conowingo WIP)
- Expected reduction to 2021
- Monitored reduction to 2021

Why are monitoring and modeling not showing the same thing?



- Uncertainty in CAST
 - BMPs implemented
 - BMP effectiveness
 - Nutrient applications
 - Watershed response
- Uncertainty in “monitored” loads
- Lag time
- Competing factors such as
 - Climate change
 - Conowingo

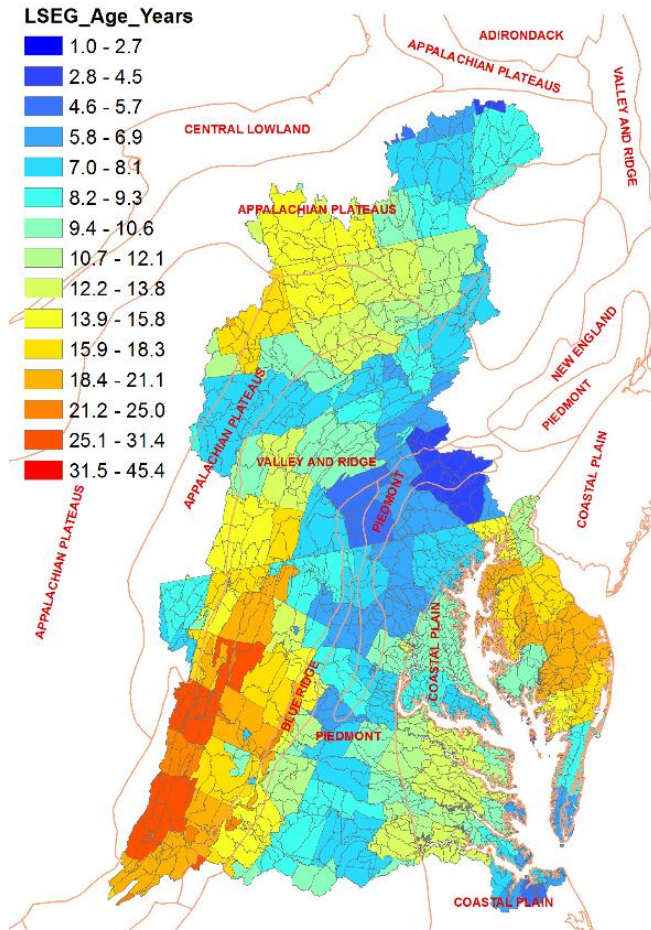
Ator, S.W., Blomquist, J.D., Webber, J.S. and Chanat, J.G., 2020. Factors driving nutrient trends in streams of the Chesapeake Bay watershed. *Journal of Environmental Quality*, 49(4), pp.812-834.



- Percent reduction to WIP (with Conowingo WIP)
- Expected reduction to 2021
- Monitored reduction to 2021

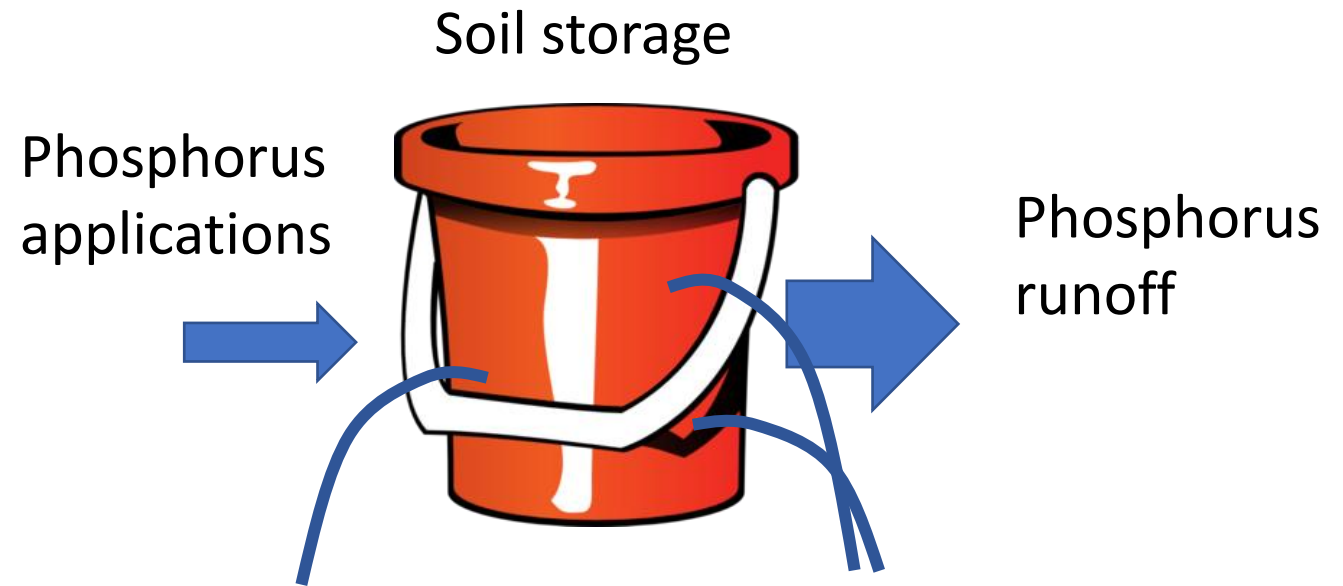
Lag times

Nitrate in groundwater



Phase 6 CAST documentation

Phosphorus in soils

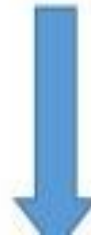


Estimated Loads to the Bay with Conowingo Dam and Reservoir at Infill Conditions

Additional Nitrogen Load: 13 million pounds

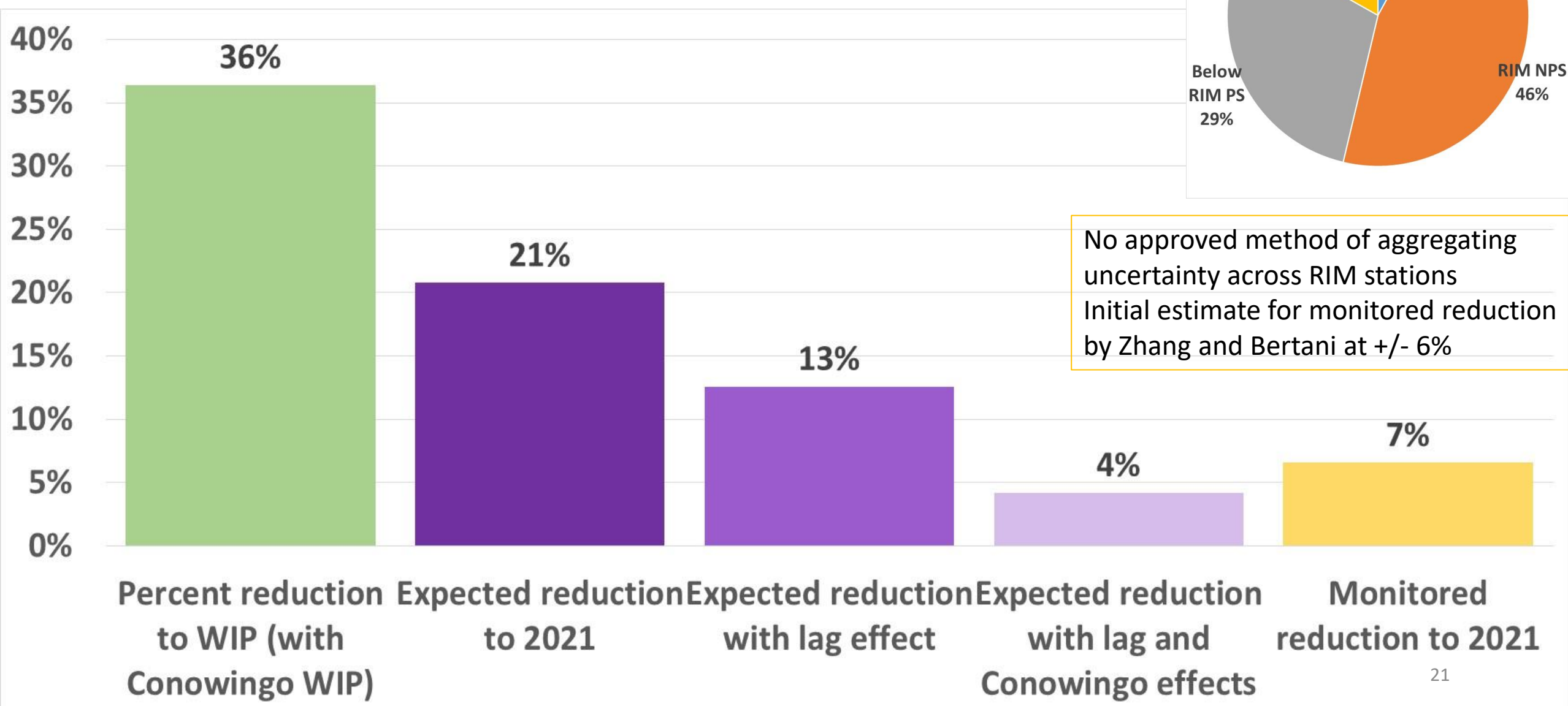


Additional Phosphorus Load: 1.8 million pounds



6 million lbs of N and 0.26 million lbs of P reduction

Lags and Conowingo account for major differences between Modeling and Monitoring

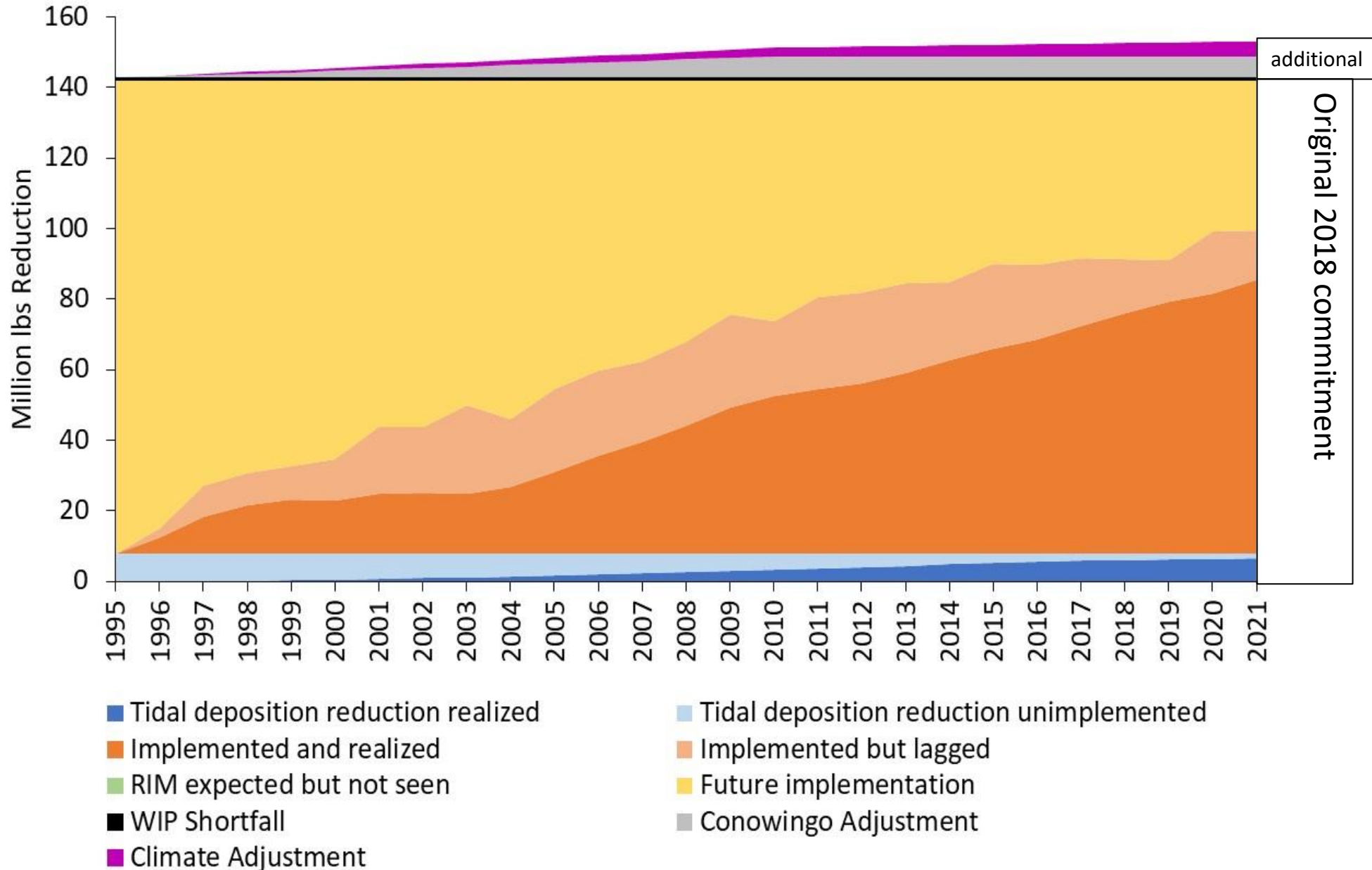


Public Indicator

Updated Annually

Web team will reformat
Including addressing
accessibility

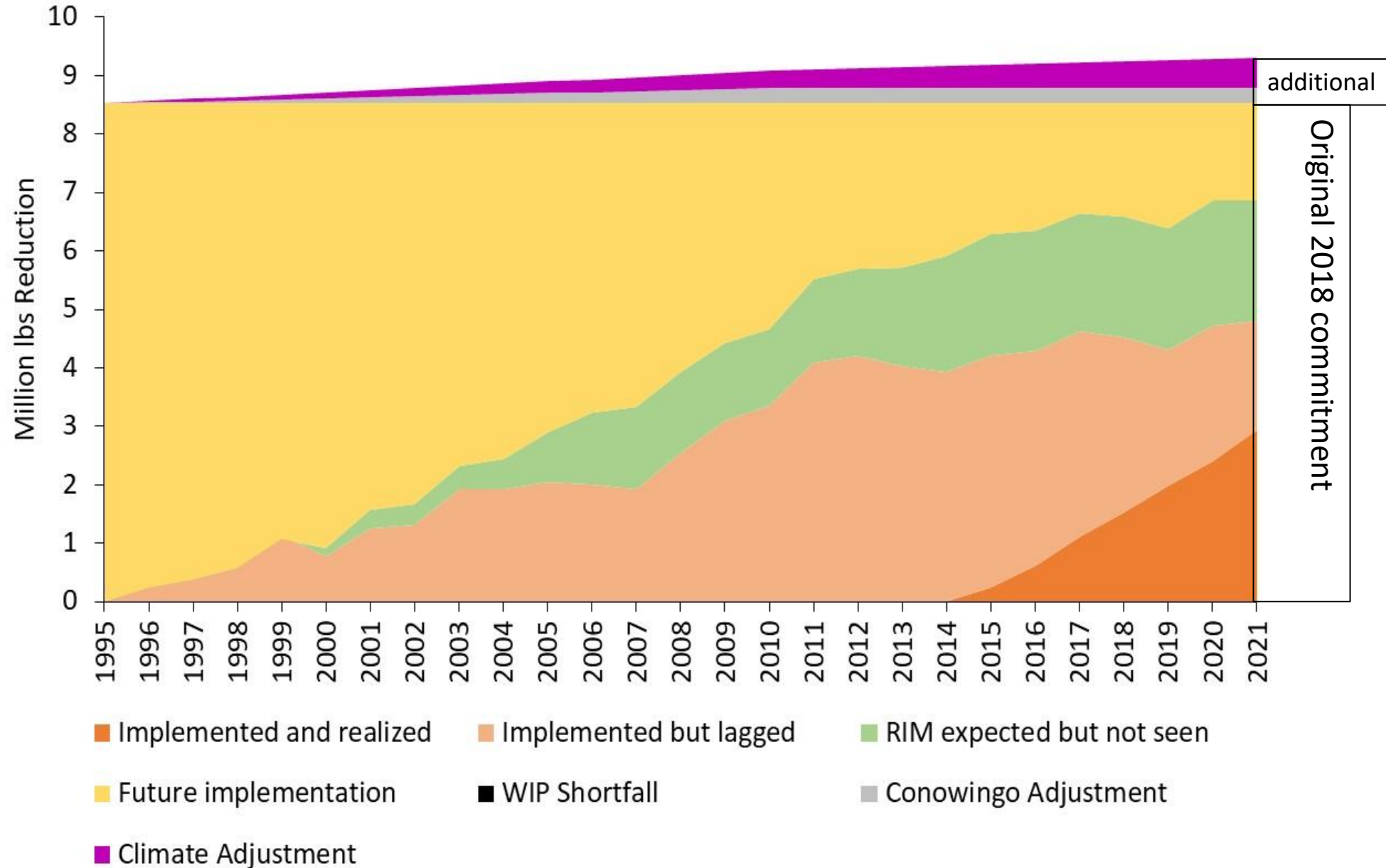
Chesapeake Bay TMDL Load Indicator Total Nitrogen



Public Indicator

Updated Annually

Chesapeake Bay TMDL Load Indicator Total Phosphorus



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Including addressing
accessibility

Location: WIP 2025 outcome

CHESAPEAKE

PROGRESS

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Abundant Life

Clean Water

Conserved Lands

Engaged Communities

Climate Change

About Us

WATER QUALITY GOAL >

2017 Watershed Implementation Plans (WIPs) Outcome

2025 Watershed Implementation Plans (WIPs) Outcome

Water Quality Standards Attainment and Monitoring Outcome

TOXIC CONTAMINANTS GOAL >

Toxic Contaminants Research Outcome

Toxic Contaminants Policy and Prevention Outcome

HEALTHY WATERSHEDS GOAL >

Healthy Watersheds Outcome

CHESAPEAKE

Helping federal, state, and local groups track the progress toward the goals and outcomes of the Chesapeake Bay Watershed Agreement.

Modeled Nitrogen Loads to the Chesapeake Bay (1985-2021)

Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector includes, in part, forests and wetlands which are preferable land use types with the lowest loading rates among sources.

[VIEW CHART](#) [VIEW TABLE](#)

Loads by Source

Loads by Jurisdiction

This stacked bar chart displays nitrogen loads in millions of pounds for the years 1985, 2009, and 2021. The chart is divided into two sections: 'Loads by Source' and 'Loads by Jurisdiction'. The 'Loads by Source' section shows the following categories: Agriculture (blue), Developed (dark blue), Wastewater (yellow), Septic (light green), Natural (teal), Atmospheric Deposition to Watershed (dark blue), and Atmospheric Deposition to Tidal Water (dark blue). The 'Loads by Jurisdiction' section shows the following categories: Agriculture (light green), Developed (teal), Wastewater (blue), Septic (yellow), and Natural (dark blue). A horizontal line at approximately 210 million pounds indicates the TMDL load.

Year	Agriculture	Developed	Wastewater	Septic	Natural	Atmospheric Deposition to Watershed	Atmospheric Deposition to Tidal Water
1985	150	20	100	10	10	10	10
2009	120	20	80	10	10	10	10
2021	100	20	60	10	10	10	10

Modeled Phosphorus Loads to the Chesapeake Bay (1985-2021)

Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector includes, in part, forests and wetlands which are preferable land use types with the lowest loading rates among sources.

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Year	Agriculture	Developed	Wastewater	Septic	Natural	Atmospheric Deposition to Watershed	Atmospheric Deposition to Tidal Water
1985	8	2	12	1	1	1	1
2009	6	2	8	1	1	1	1
2021	4	2	6	1	1	1	1

Chesapeake Bay TMDL Load Indicator Total Nitrogen

This area chart shows the Chesapeake Bay TMDL Load Indicator for Total Nitrogen from 1995 to 2021. The y-axis represents the load in millions of pounds, ranging from 0 to 160. The x-axis represents the years from 1995 to 2021. The chart is divided into several categories: Tidal deposition reduction realized (blue), Tidal deposition reduction unimplemented (light blue), Implemented and realized (orange), Implemented but lagged (light orange), RIM expected but not seen (green), Future implementation (yellow), WIP Shortfall (black), Conowingo Adjustment (grey), and Climate Adjustment (purple). The total load is shown as a stacked area, with the TMDL load indicated by a horizontal line at approximately 140 million pounds.

Year	Tidal deposition reduction realized	Tidal deposition reduction unimplemented	Implemented and realized	Implemented but lagged	RIM expected but not seen	Future implementation	WIP Shortfall	Conowingo Adjustment	Climate Adjustment
1995	10	0	10	10	0	110	0	0	0
2000	10	0	10	10	0	110	0	0	0
2005	10	0	10	10	0	110	0	0	0
2010	10	0	10	10	0	110	0	0	0
2015	10	0	10	10	0	110	0	0	0
2020	10	0	10	10	0	110	0	0	0
2021	10	0	10	10	0	110	0	0	0

Chesapeake Bay TMDL Load Indicator Total Phosphorus

This area chart shows the Chesapeake Bay TMDL Load Indicator for Total Phosphorus from 1995 to 2021. The y-axis represents the load in millions of pounds, ranging from 0 to 10. The x-axis represents the years from 1995 to 2021. The chart is divided into several categories: Implemented and realized (orange), Implemented but lagged (light orange), RIM expected but not seen (green), Future implementation (yellow), WIP Shortfall (black), Conowingo Adjustment (grey), and Climate Adjustment (purple). The total load is shown as a stacked area, with the TMDL load indicated by a horizontal line at approximately 13 million pounds.

Year	Implemented and realized	Implemented but lagged	RIM expected but not seen	Future implementation	WIP Shortfall	Conowingo Adjustment	Climate Adjustment
1995	1	1	1	5	0	0	0
2000	1	1	1	5	0	0	0
2005	1	1	1	5	0	0	0
2010	1	1	1	5	0	0	0
2015	1	1	1	5	0	0	0
2020	1	1	1	5	0	0	0
2021	1	1	1	5	0	0	0

Partnership Product for Data Dashboard

Plus all years in between. Updated Annually

	Nitrogen					Phosphorus			
Category	1995	2005	2015	2021		1995	2005	2015	2021
WIP Shortfall	0.92	6.58	10.25	11.25		-0.87	-0.50	-0.21	-0.09
WIP Shortfall	0.92	0.92	0.92	0.92		-0.87	-0.87	-0.87	-0.87
Conowingo Adjustment	0.00	4.00	6.01	6.01		0.00	0.17	0.26	0.26
Climate Adjustment	0.00	1.66	3.32	4.32		0.00	0.20	0.40	0.52
RIM Unimplemented	68.30	43.75	26.73	26.65		6.33	4.28	2.18	1.77
RIM Unimplemented Conowingo	6.67	6.67	6.67	6.67		0.14	0.14	0.14	0.14
RIM expected but not seen	0.00	0.00	0.00	0.00		0.00	1.77	2.09	2.07
RIM Lagged	0.00	17.94	21.39	16.87		0.00	2.29	3.58	2.40
RIM Conowingo Conversion	0.00	8.81	11.81	11.26		0.00	1.86	2.95	2.30
RIM Monitored	0.00	-2.20	8.38	13.53		0.00	-3.88	-4.48	-2.21
Below-RIM PS Implemented	0.00	17.56	30.04	37.19		0.00	0.32	1.25	1.38
Below-RIM PS Unimplemented	37.41	19.85	7.38	0.22		1.57	1.25	0.32	0.19
Below-RIM Estimated	0.00	-1.11	7.85	15.67		0.00	0.79	0.52	1.48
Below-RIM Lagged	0.00	5.60	2.71	-2.95		0.00	-0.25	0.38	-0.55
Below-RIM Unimplemented	21.44	16.96	10.88	8.72		1.36	0.82	0.46	0.43
Tidal Deposition Reduction Realized	0.00	1.68	5.18	6.50					
Tidal Deposition Reduction Unimplemented	7.92	6.24	2.74	1.42					

Station-level dashboard Product



Qian Zhang

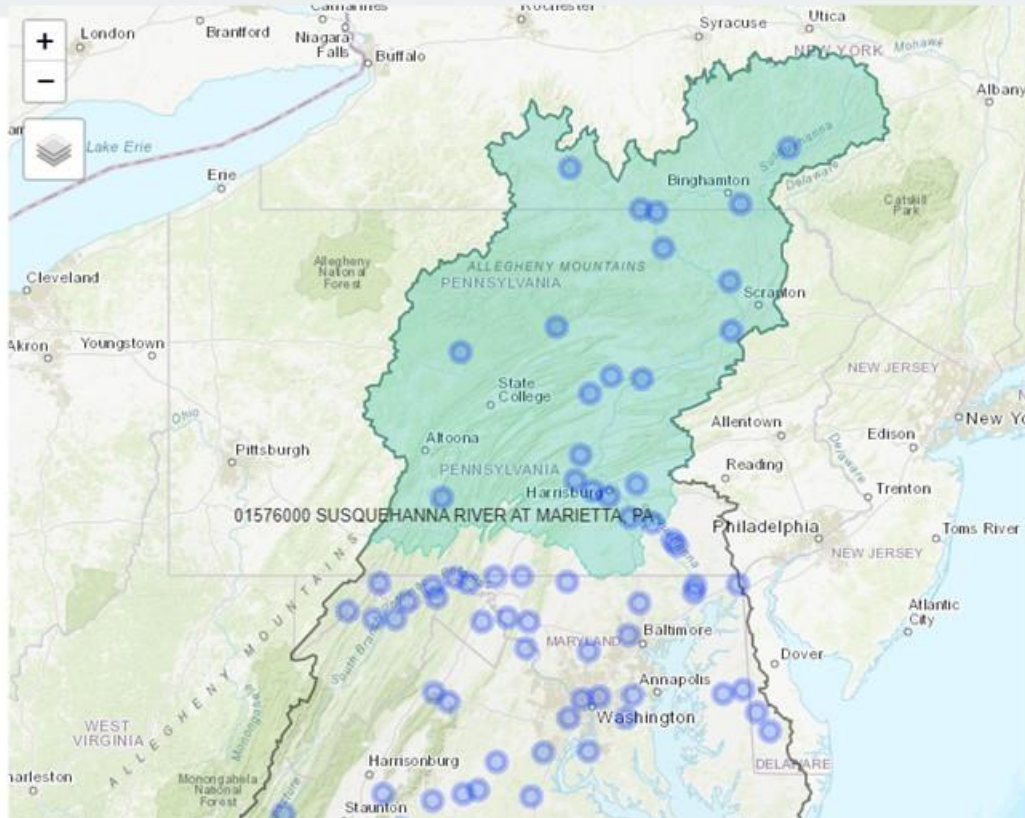
Step 1: Select the water-quality parameter:

Total Nitrogen

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

Map

Table



About

Timeseries

Goal

Progress

Table

Download

Station

Your selected station is SUSQUEHANNA RIVER AT MARIETTA, PA:

- USGS ID: 01576000
- Area (km²): 67349.2
- Major Basin: Susquehanna
- Latitude: 40.054541
- Longitude: -76.530799

Data Availability

Total Nitrogen: 1987-2020.
Total Phosphorus: 1987-2020.
Suspended Sediment: 1987-2020.

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](#)).

Contact

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Contributors

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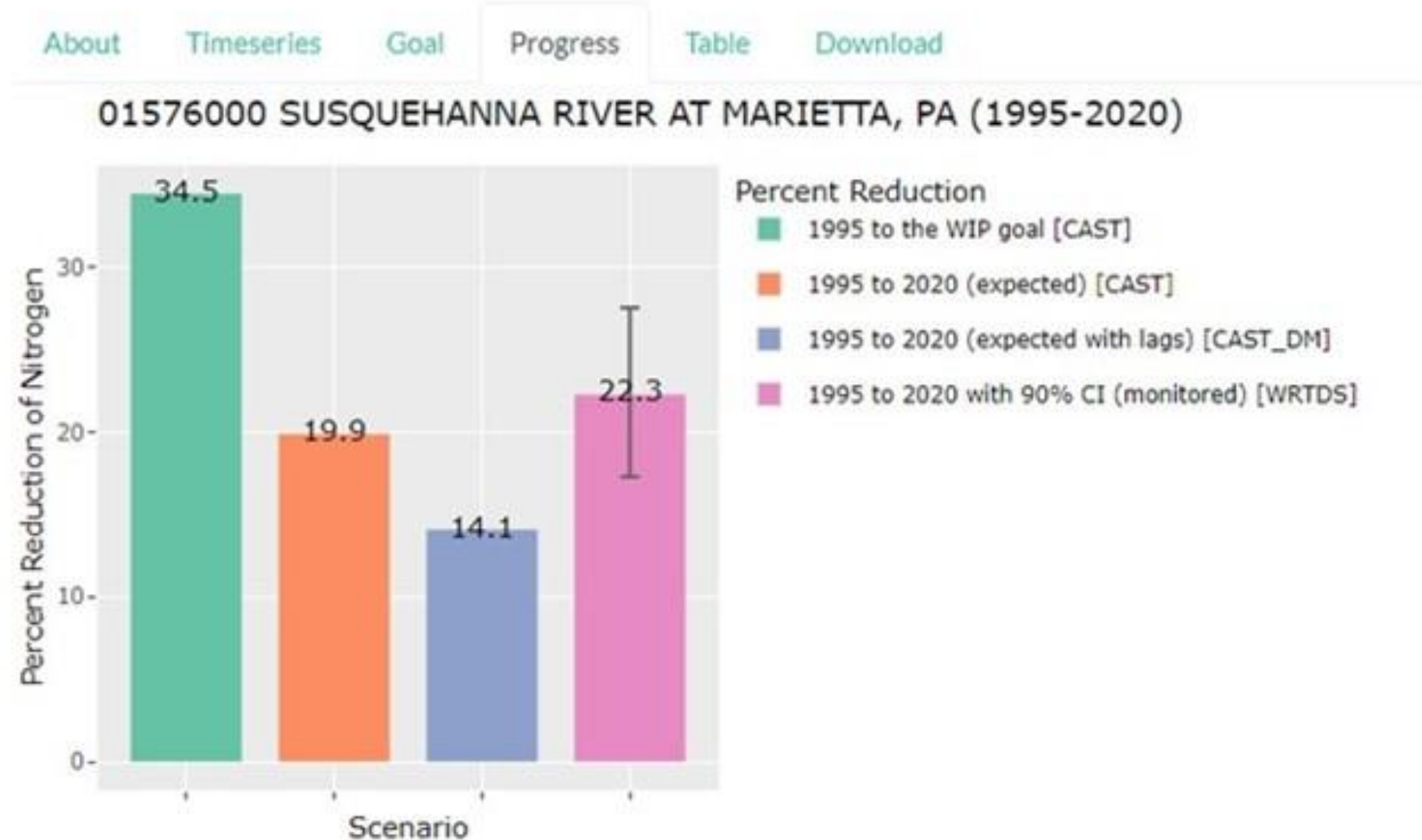
Last updated on March 10, 2023.

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

Station-level dashboard Product



Qian Zhang



Station-level dashboard Product



Qian Zhang

About

Timeseries

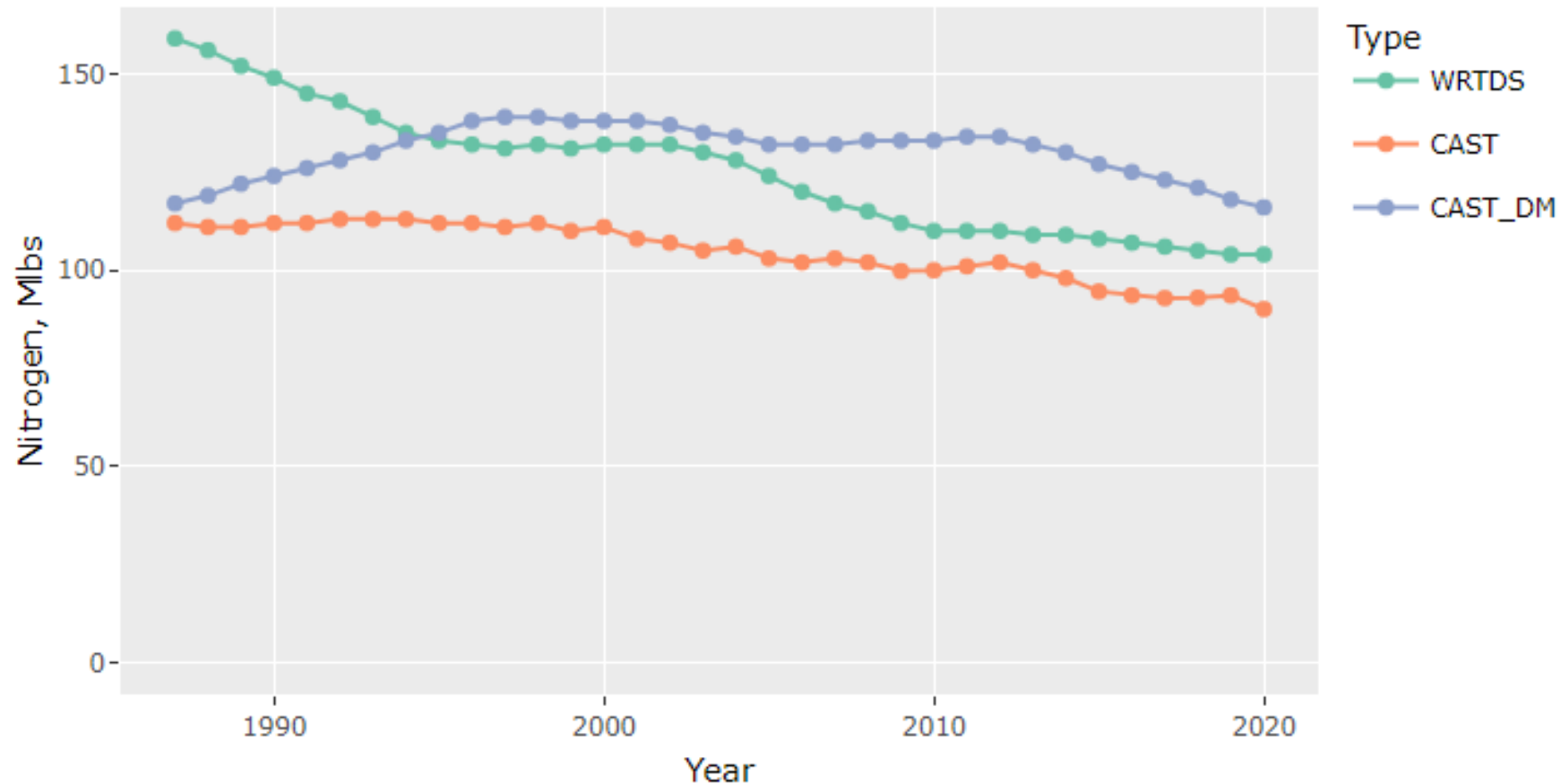
Goal

Progress

Table

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01576000 SUSQUEHANNA RIVER AT MARIETTA, PA



Station-level dashboard Product



Qian Zhang

About

Timeseries

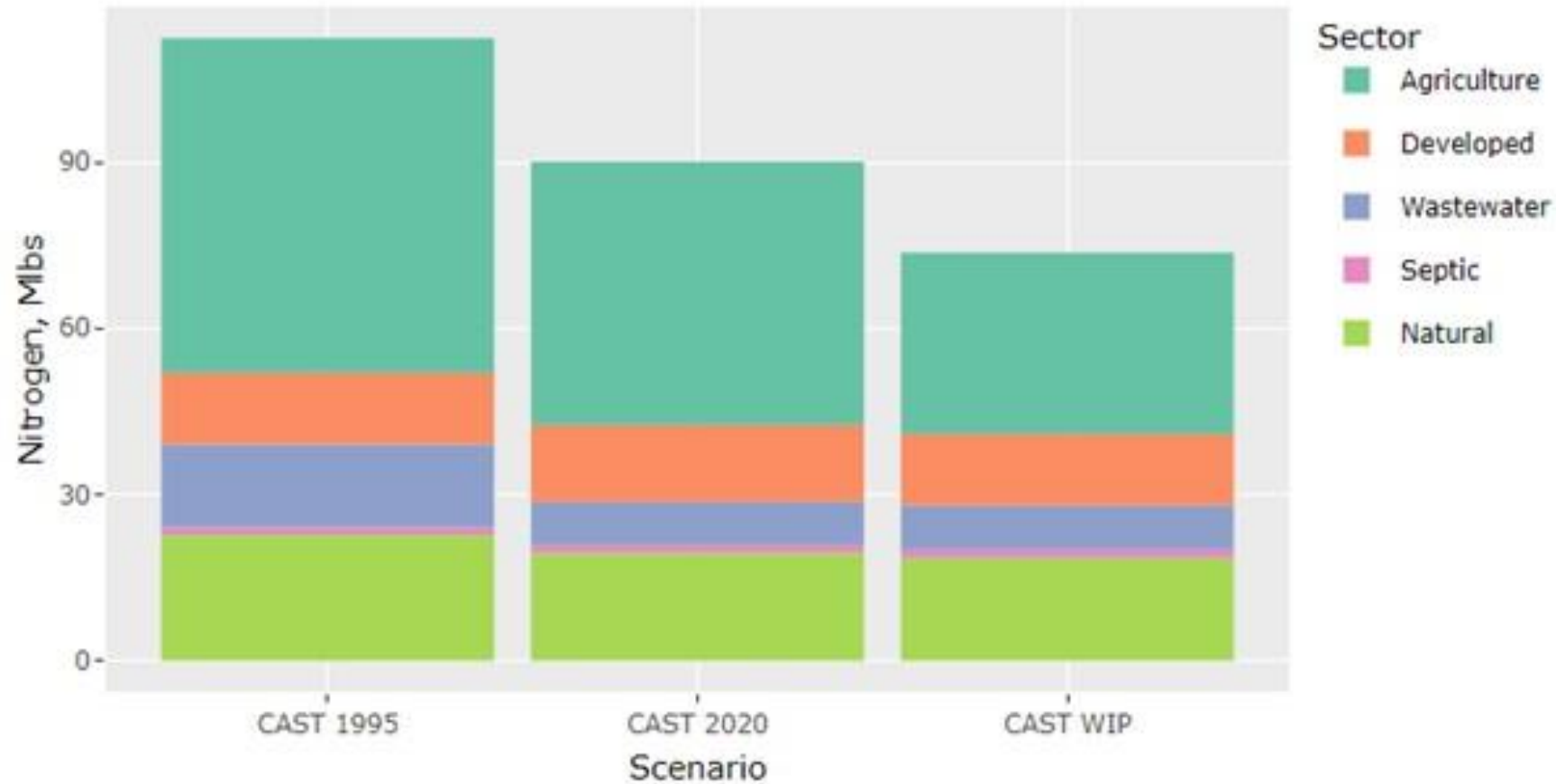
Goal

Progress

Table

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



Station-level dashboard Product



Qian Zhang

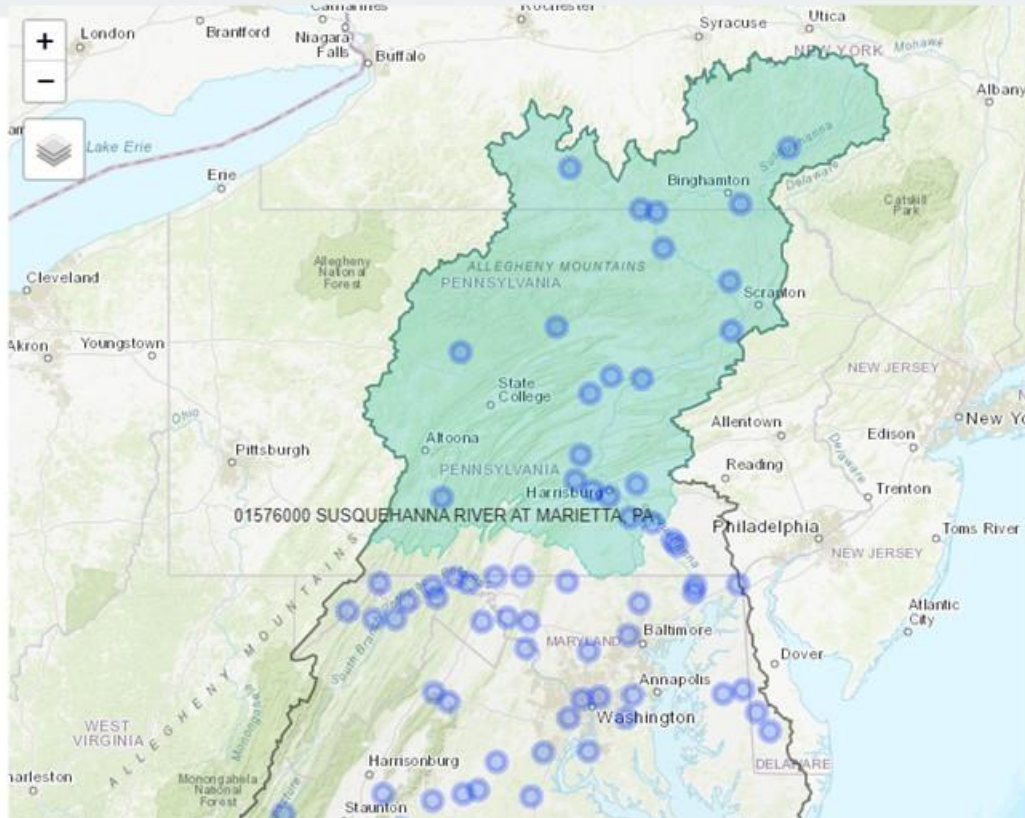
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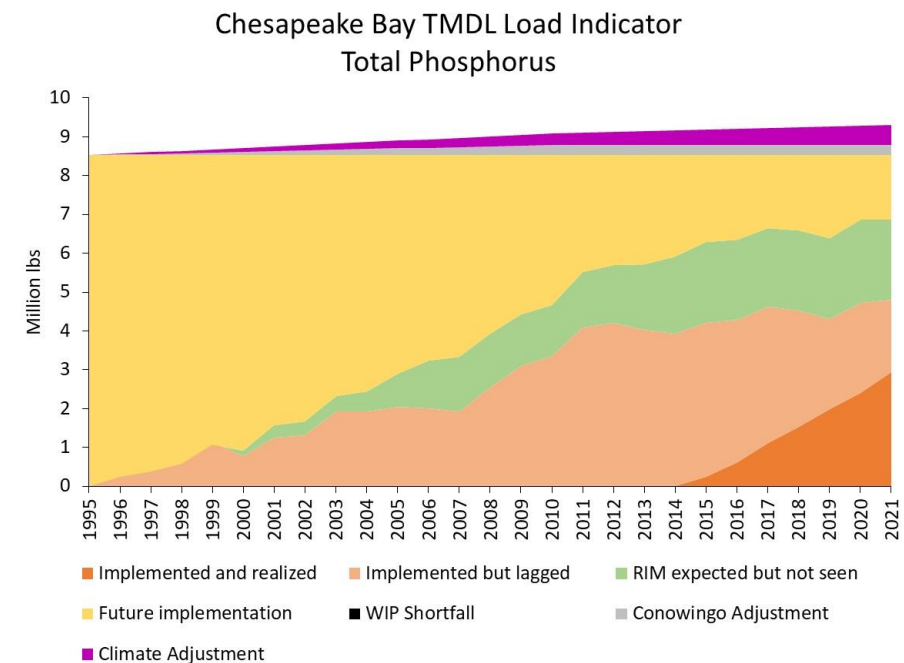
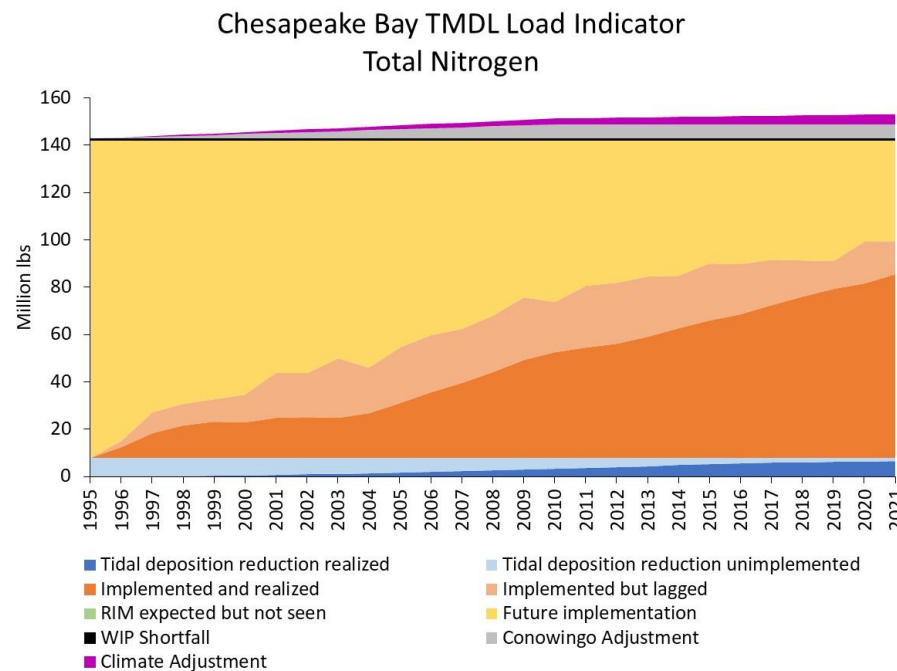
https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

Partnership Vetting

- 9/2021 CBPO discussions
 - 7/2022 USGS-led Factors Affecting Trends Group
 - 8/2022 Status and Trends Workgroup
 - 10/2022 Watershed Technical Workgroup
 - 11/2022 WQGIT
 - 3/2023 Status and Trends Workgroup
-
- Each meeting produced recommendations that strengthened the product.

Decision

- Approve the Integrated Watershed TMDL Indicator as a supplemental indicator under the WIP 2025 Outcome



- Begin working with the CBP web and communications teams

Next Steps

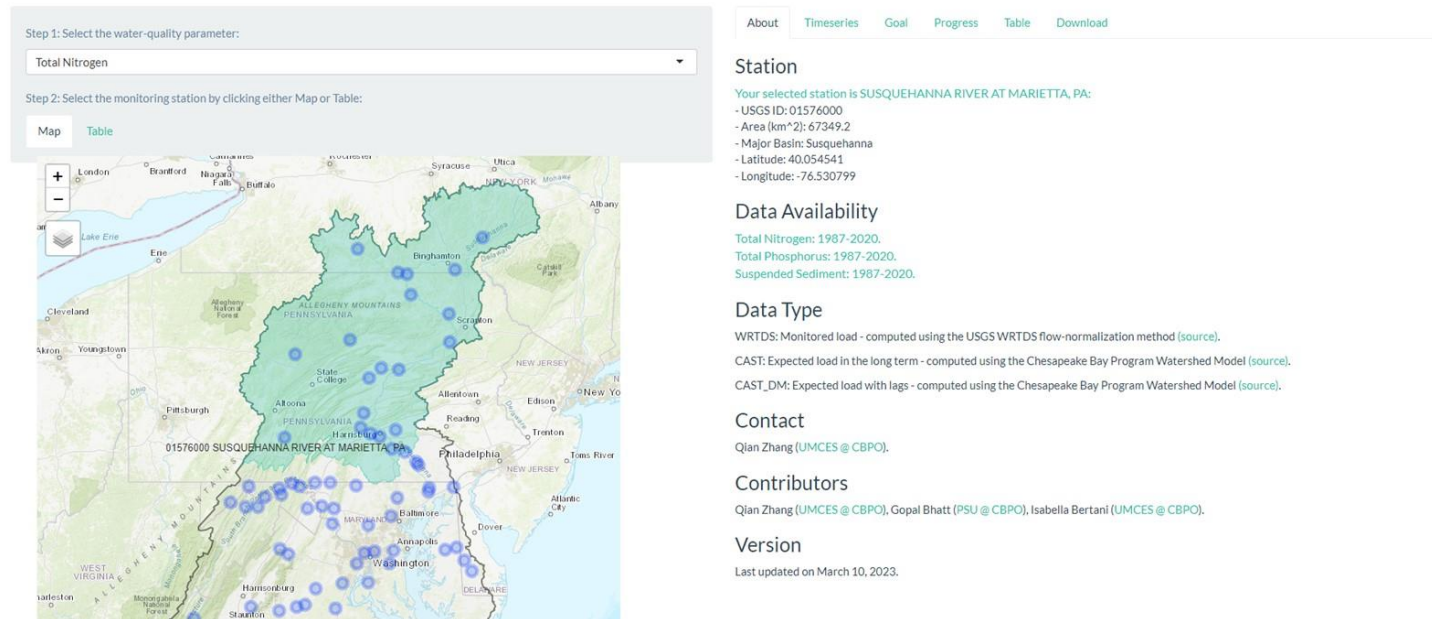
- Add the annual finer-category data to the nontidal data dashboard

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Below-RIM PS Unimplemented	37.41	19.85	7.38	0.22		1.57	1.25	0.32	0.19
Below-RIM Estimated	0.00	-1.11	7.85	15.67		0.00	0.79	0.52	1.48
Below-RIM Lagged	0.00	5.60	2.71	-2.95		0.00	-0.25	0.38	-0.55
Below-RIM Unimplemented	21.44	16.96	10.88	8.72		1.36	0.82	0.46	0.43
Tidal Deposition Reduction Realized	0.00	1.68	5.18	6.50					
Tidal Deposition Reduction Unimplemented	7.92	6.24	2.74	1.42					

- No formal decision needed from WQGIT, but certainly open for advice and direction

Next Steps

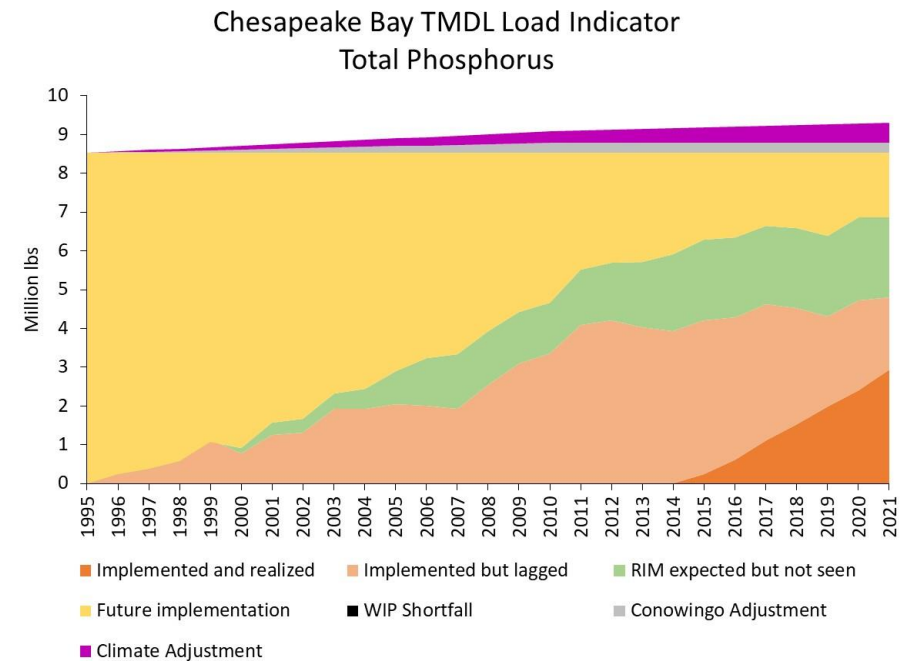
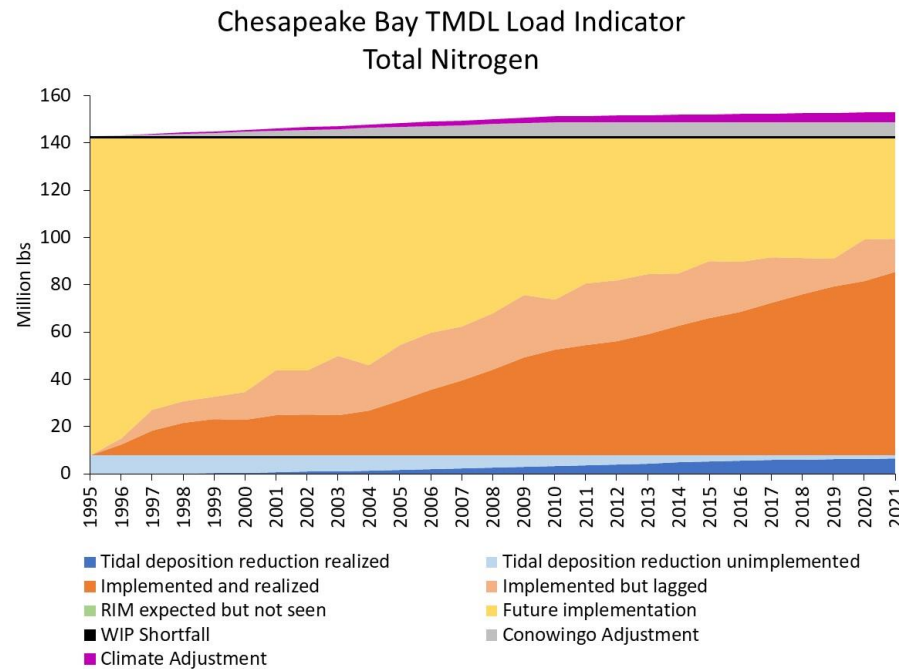
- Continue working on the station-level dashboard product



- No formal decision needed from WQGIT, but encourage partners to try it out and comment

Request Decision

- Approve the Integrated Watershed TMDL Indicator as a supplemental indicator under the WIP 2025 Outcome

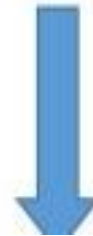


Estimated Loads to the Bay with Conowingo Dam and Reservoir at Infill Conditions

Additional Nitrogen Load: 13 million pounds

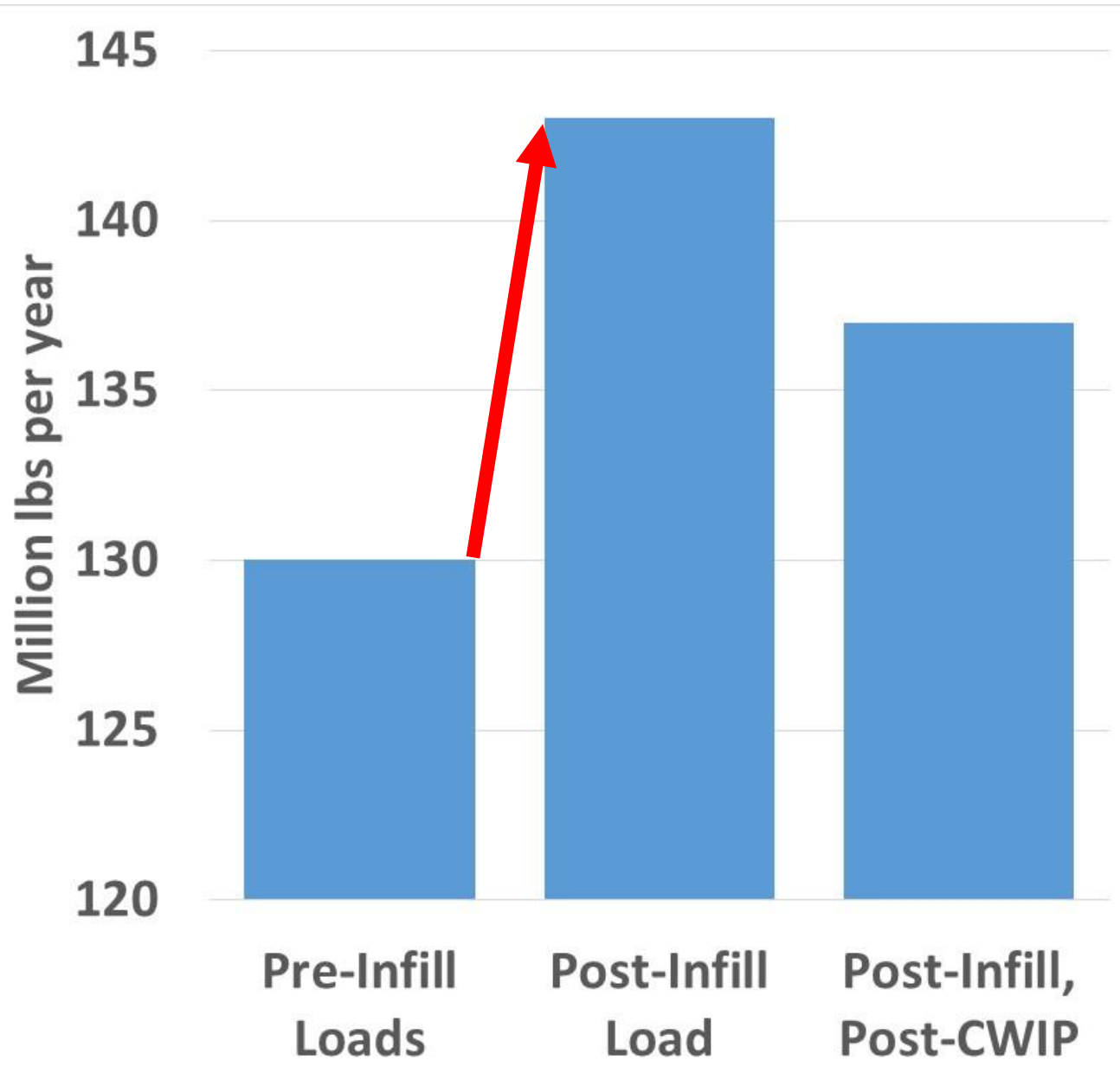


Additional Phosphorus Load: 1.8 million pounds



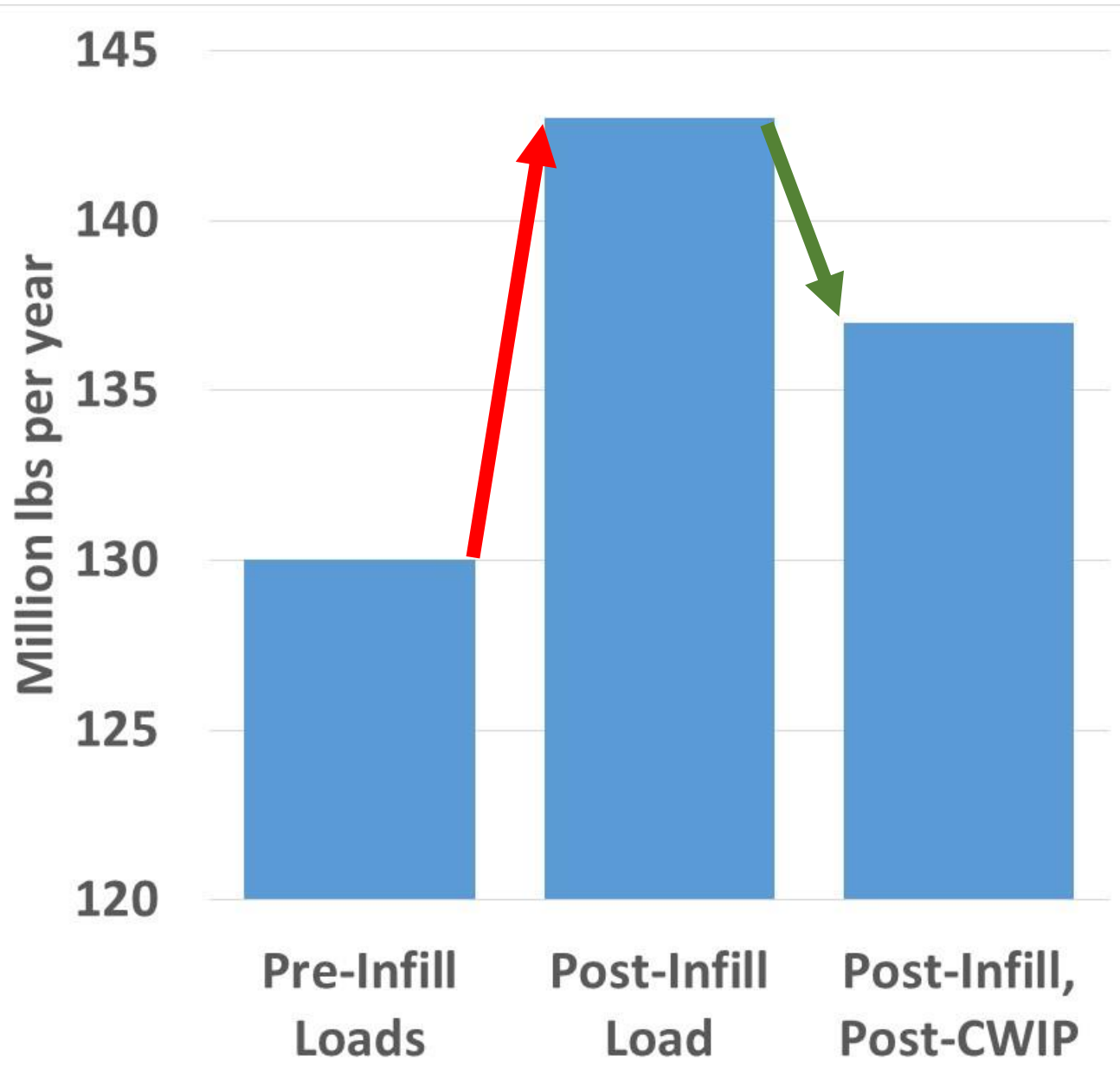
HOWEVER: These are less bioavailable nutrients and its delivery to Bay is dependent on large storm events. Reduction equivalent to 6 million pounds of Nitrogen and 0.26 million pounds of Phosphorus

Conowingo infill raises the assimilative capacity



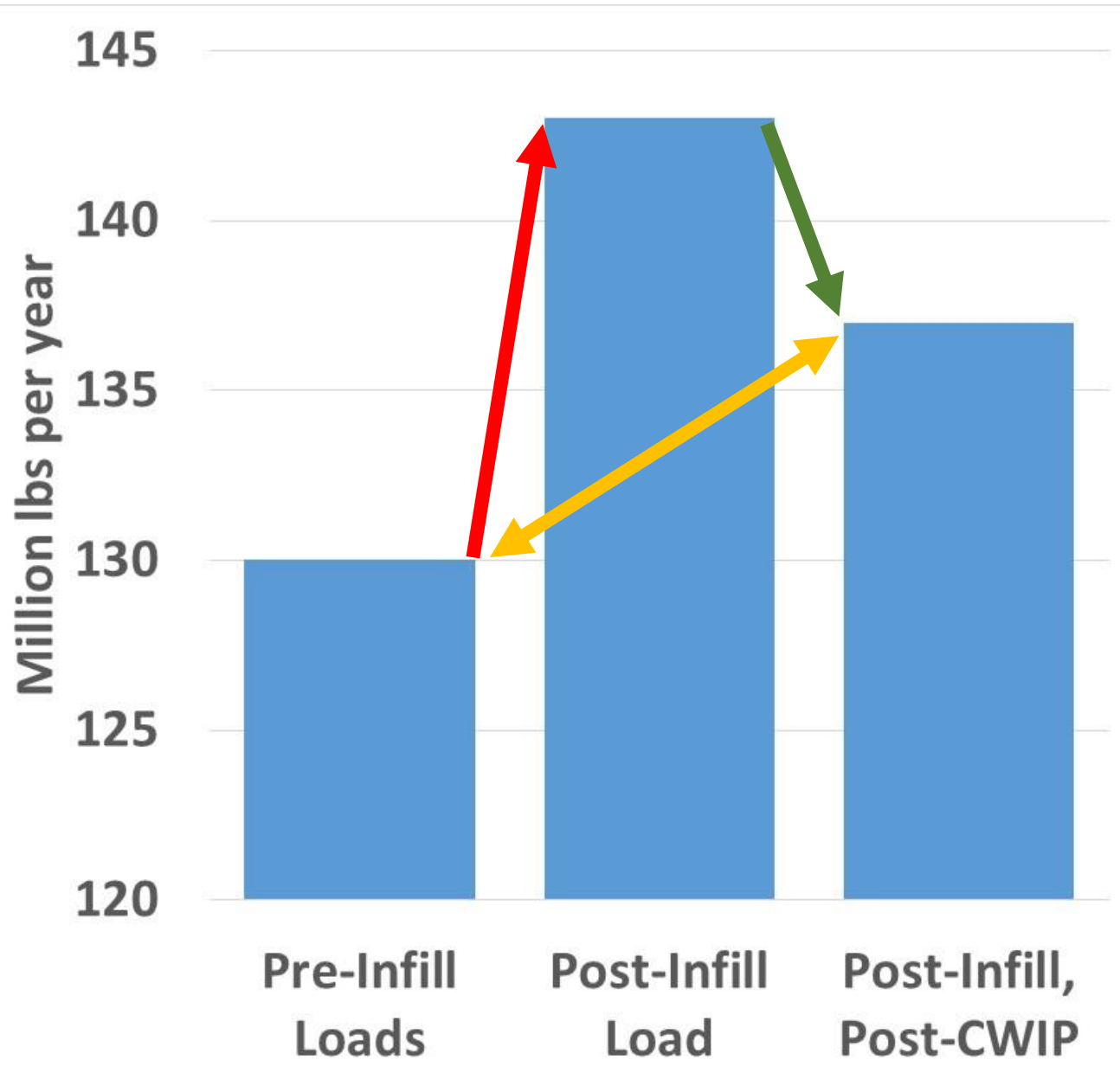
→ All else being equal, Conowingo raised loads by 13 million (mostly organic and non-summer) lbs

Conowingo infill raises the assimilative capacity



- All else being equal, Conowingo raised loads by 13 million (mostly organic and non-summer) lbs
- The infill effect can be removed by a watershed reduction of 6 million (more inorganic and summer) lbs

Conowingo infill raises the assimilative capacity



- All else being equal, Conowingo raised loads by 13 million (mostly organic and non-summer) lbs
- The infill effect can be removed by a watershed reduction of 6 million (more inorganic and summer) lbs
- The TMDL water quality is equivalent at 130 pre-infill and 137 post-infill

The water quality change “Seen” by the Bay is greater than the monitoring results by 7 million pounds because of the infill effect