

# Watershed Modeling Workplan Options

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10/25/2021

WQGIT

# CBP Watershed Modeling Products

TMDL tracking

Existing

CAST6-2017,  
CAST6-2019...  
CAST6-2025

CAST is updated for each milestone period.  
Updates are constrained.  
1995 load cannot be changed  
Modifications can be made that better reflect trends from 1995 through current.

Long term?

CAST7-2025,  
CAST7-2027...

Phase 7 CAST can incorporate any changes from Phase 6  
  
2-year updates will be similarly constrained

Calibration,  
Estuarine loading  
Water supply

P6  
Dynamic  
Model

P7  
Dynamic  
Model

## Opportunity

Fine-scale  
landscape metrics

Land Use

Computing  
Power

New  
Science

Fine-scale  
tools  
(field doc)

CAST7-2025,  
CAST7-2027...

## Partnership Need

PSC  
directives

WQGIT  
needs

STAC recs

Other GIT  
needs

Water  
supply  
partners

P7 CAST  
DM

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PSC  
directives

1. Reassess 2035 climate in 2025
2. Don't change planning targets until 2025

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NHD100k hourly flow & temperature  
Low flow extremes ; Reservoirs

Other GIT  
needs

CAST inputs and outputs at NHD100k or NHD24k  
Time-averaged N, P, S, flow, temp characteristics

STAC recs

Finer scale  
Better characterize sources and sinks  
Uncertainty Quantification (including BMPs)  
Formalized optimization of CAST calibration

Revolutionize sediment  
Match with monitoring data  
More models in ensemble

WQGIT  
needs

Science needs database – 1 science need: Finer Scale

- 1) refine urban phosphorus sensitivities
- 2) investigate the impact of urban BMPs using SWAT and/or SWMM models.

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### **Finer scale**

#### **Better characterize sources and sinks**

Uncertainty Quantification (including BMPs)  
Formalized optimization of CAST calibration

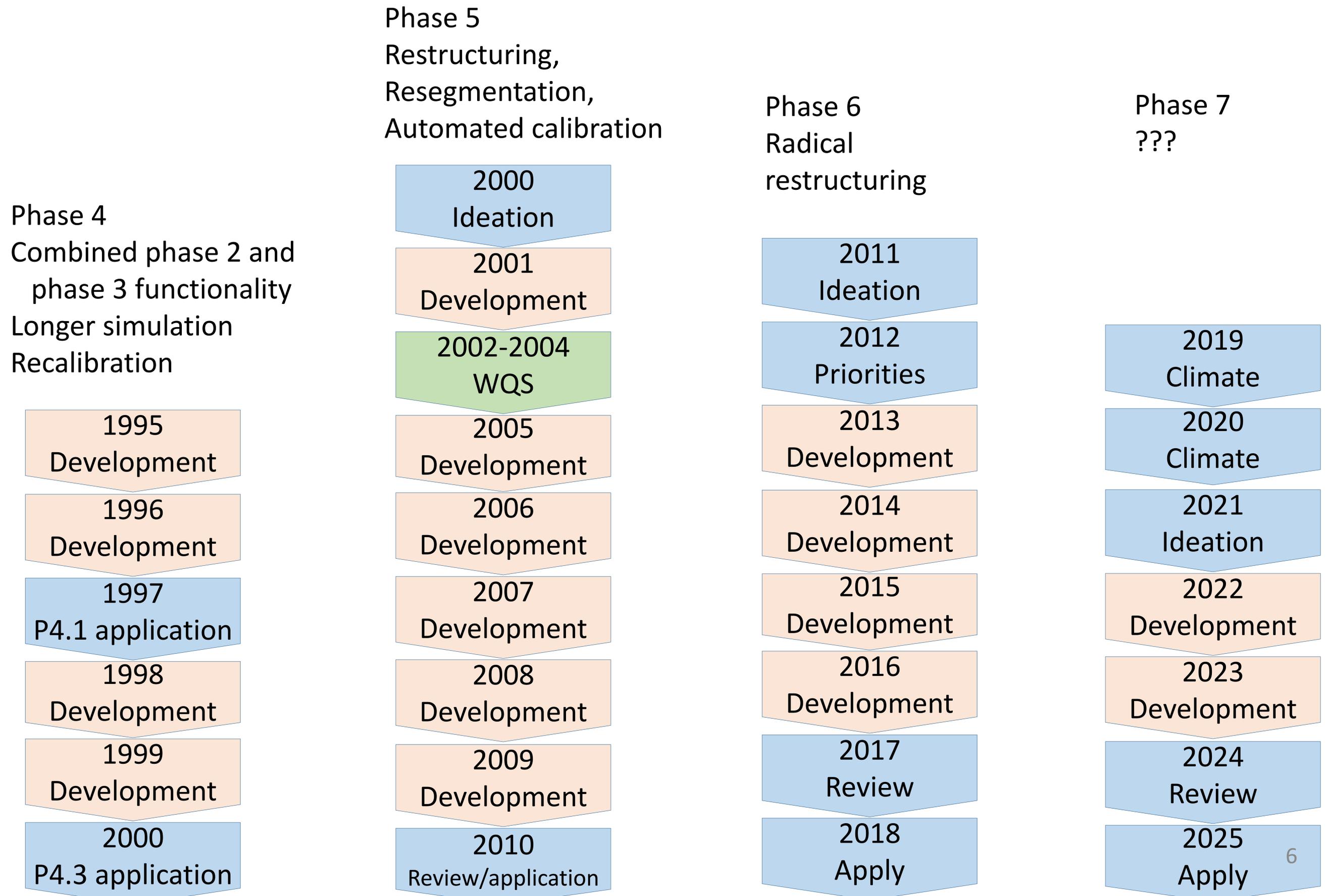
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# Model Development Schedules



2022  
Development

2023  
Development

2024  
Review

2025  
Apply

- WQGIT gives priorities – October 2021
- 2 important questions
  - What are we doing in 2025?
  - What modeling improvements will support 2025 and future decisions?
- Four Bins
  - Complete by 2023
  - Continue to work on for a later model
  - Encourage research
  - Partnership does not want this done

# Existing Priorities – these are happening

- Land use change 1985-2035
  - Resources in place
  - Use land use directly rather than combining with other data sets
  - Consistent land use from meter-scale through watershed scale
- Estuarine model development (separate document)
  - Much finer scale in shallow water
  - Allow analysis of local influence on water quality
  - Address climate change in the shallows

Potential Areas of Focus	Recommendations	Impacts Estuarine Model	Impacts CAST	Level of effort	Benefits
Finer-scale modeling	WQGIT, other GITs, STAC	✓	✓	High	Greater accuracy watershed modeling; Enables fine scale targeting of practices; Needed for some co-benefits
Spatially explicit CAST	Non-CB TMDL partners		✓	Medium	Enables CAST output on a fine scale
Physical process simulation	STAC, WQGIT other GITs, CBPO	✓	✓	Low-High	Greater watershed model accuracy overall
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WQ standards Assessment	WQGIT, STAC			Low-Medium	Potential to assess all tidal oxygen standards and to delist segments
BMP reporting transparency	WQGIT		✓	High	Understanding of the reporting process

- Scale Topics

- Finer-scale modeling – changing scale of the underlying model
- Spatially explicit CAST – Allowing the use of CAST at a user-defined scale

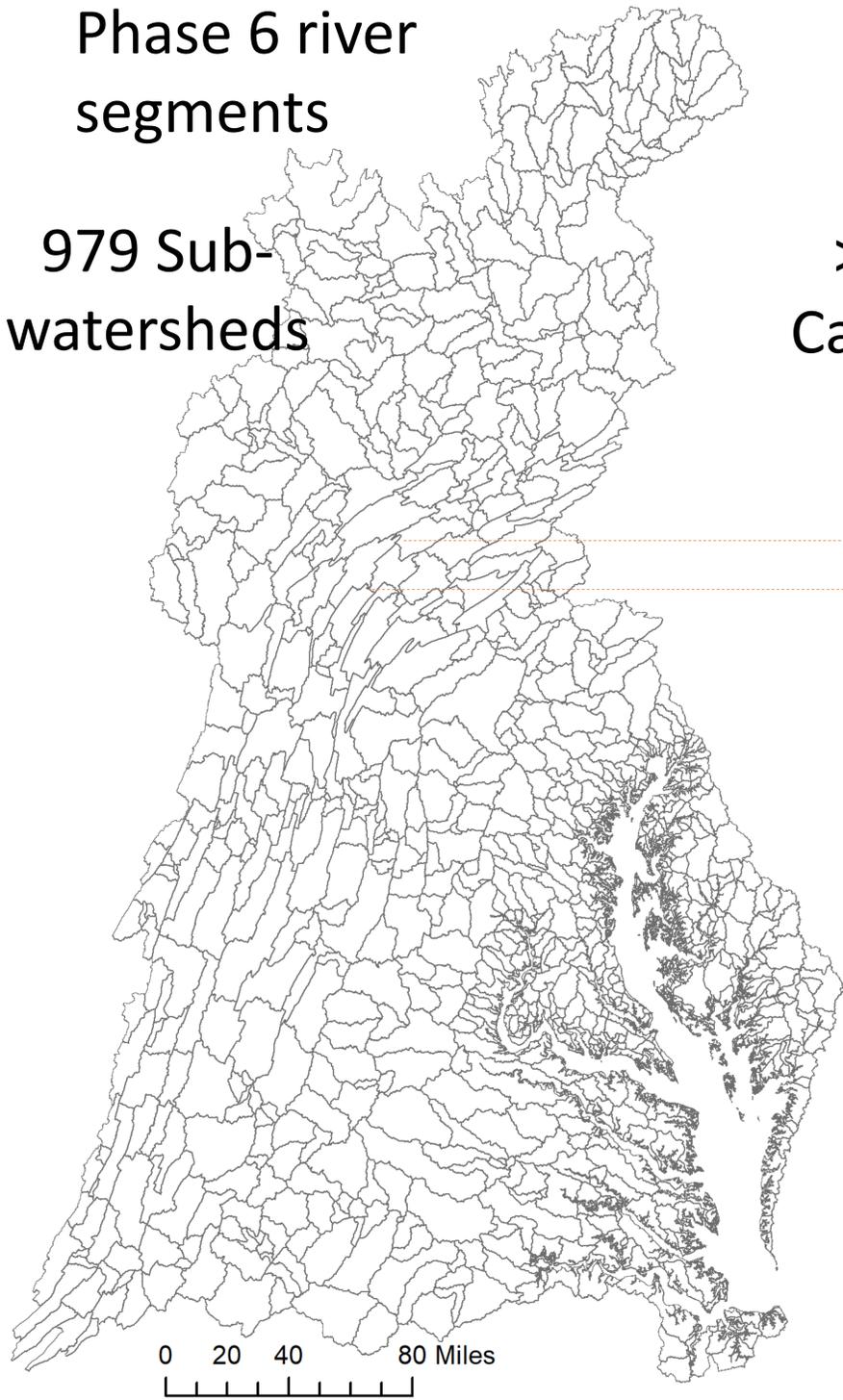
- Process Topics

- Physical processes – improving the accuracy of nutrient and sediment transport and other important processes.
- Nutrient applications – improving the process of determining the inputs of fertilizer and manure

# Finer-Scale Modeling

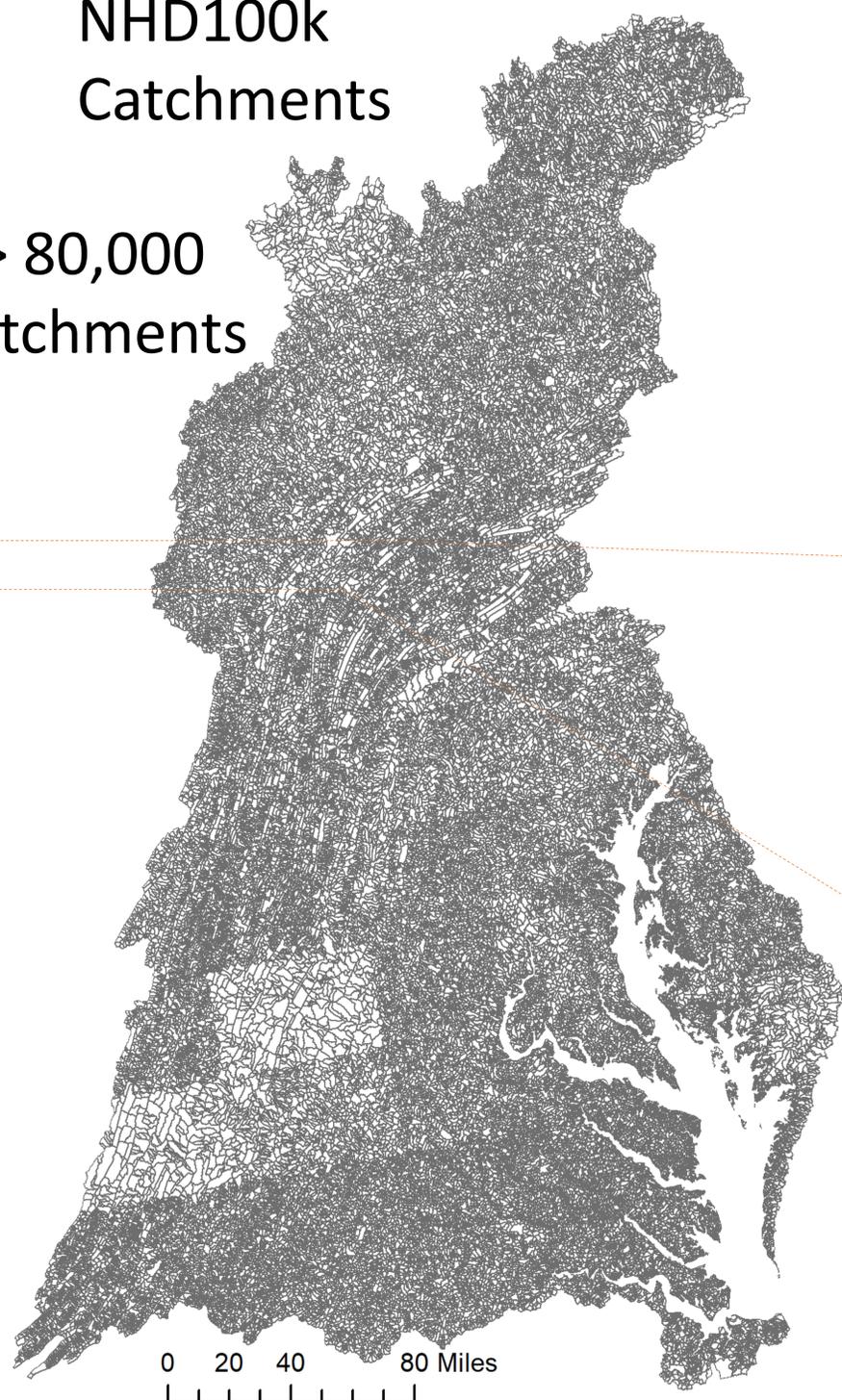
Phase 6 river segments

979 Sub-watersheds

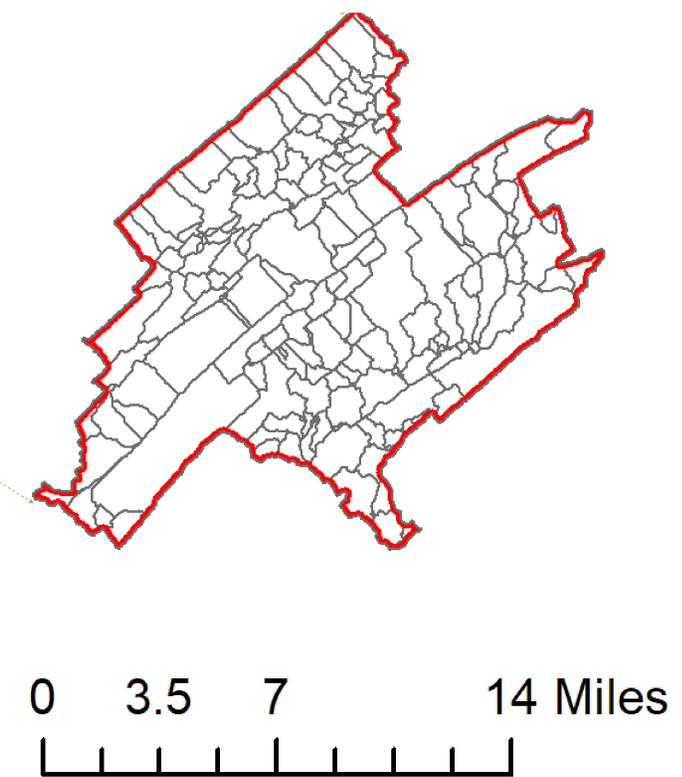
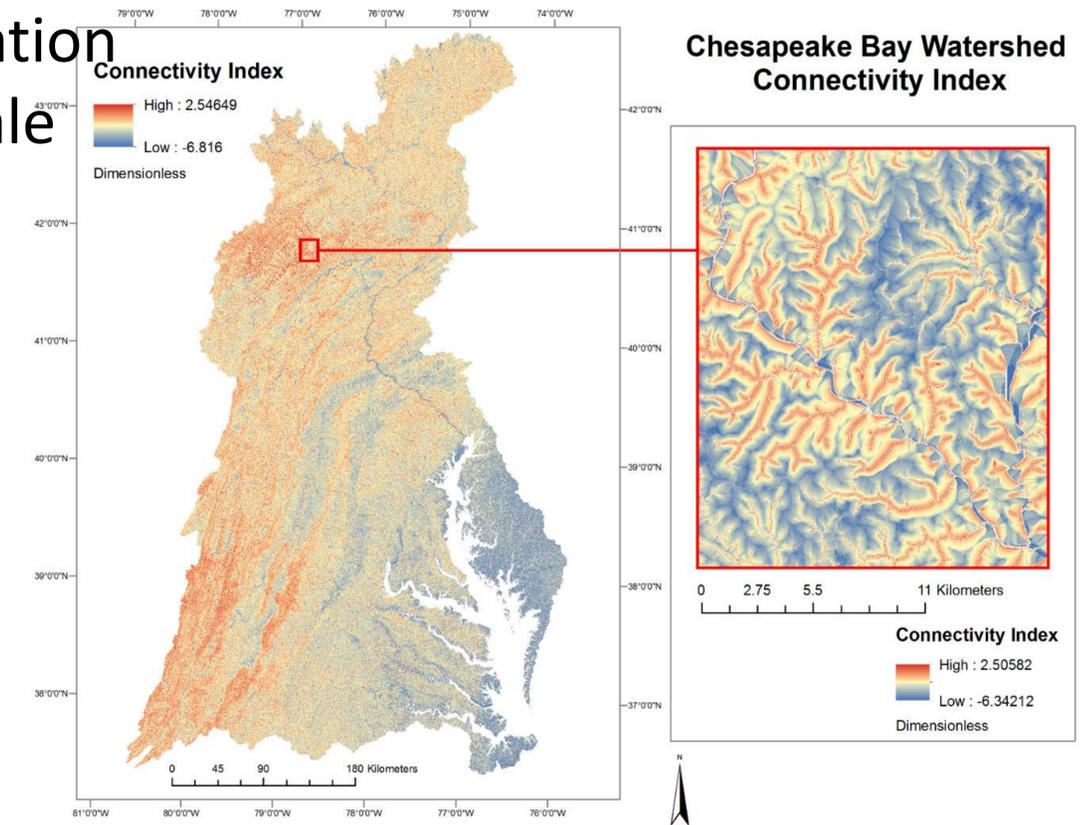


NHD100k Catchments

> 80,000 Catchments

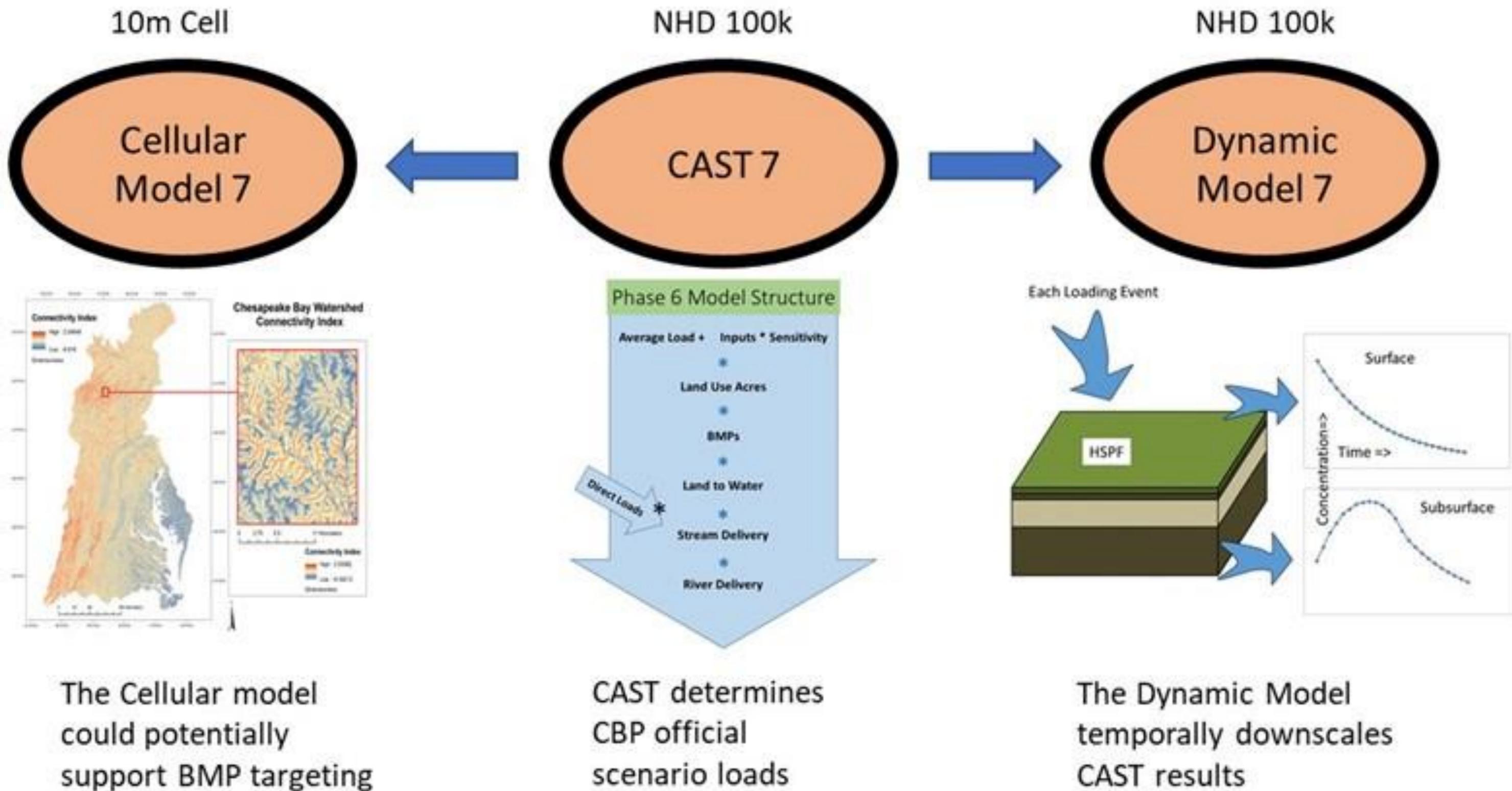


Transport information on a 10-meter scale



**Greater accuracy watershed modeling; Enables fine scale targeting of practices; Needed for some co-benefits**

# Full finer-scale proposal



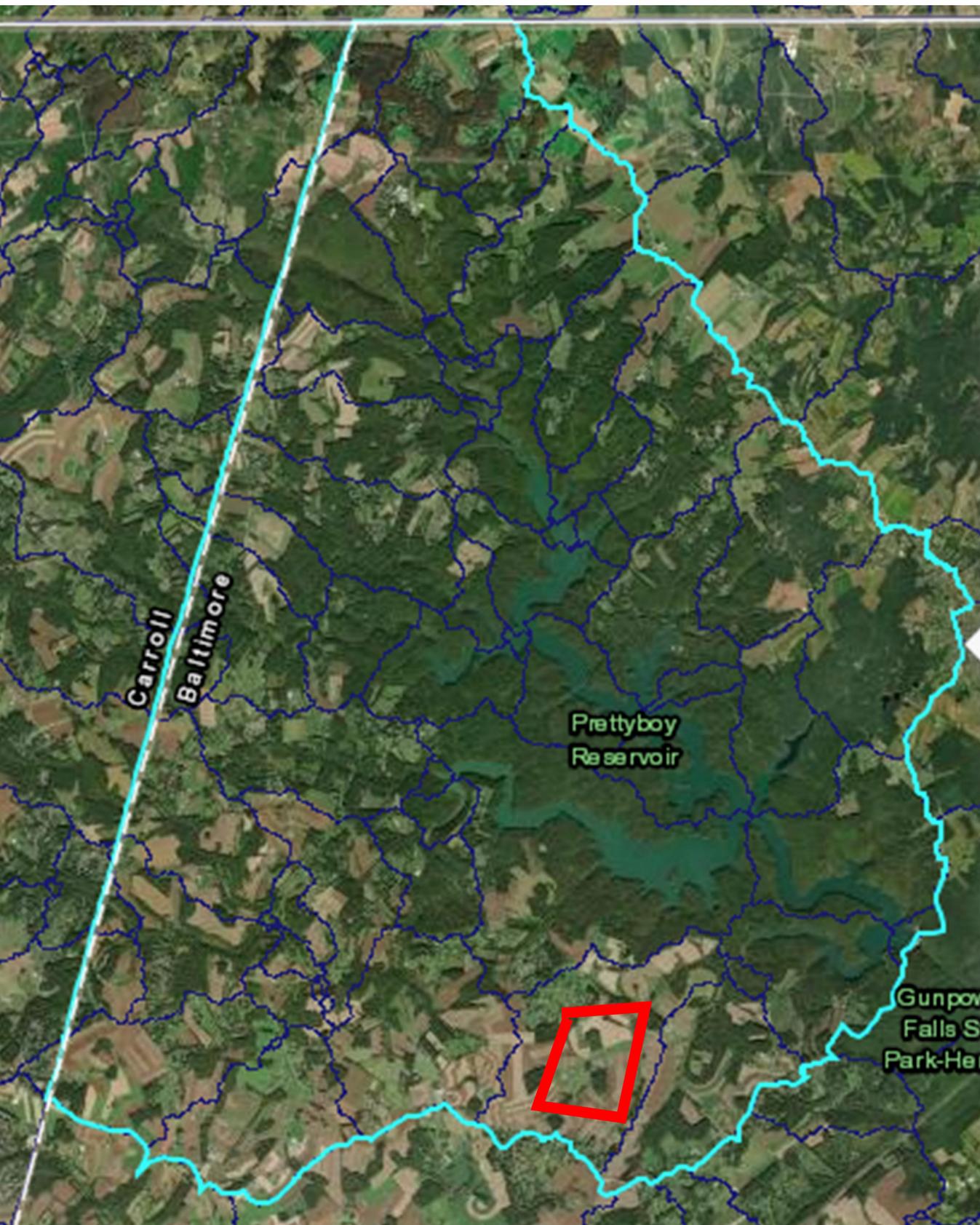
# Many options

- Watershed delivery factors are already on the NHD100k scale. NHD-scale model could be implemented in CAST with currently available data
- A la carte options
  - Cellular model
  - Dynamic model at the NHD100k scale
  - Improvements in calibration
  - Longer simulation time
- Key Questions:
  - What scale for CAST output?
  - Do you support opportunity for downscaling?

# Fine-Scale modeling – Benefits

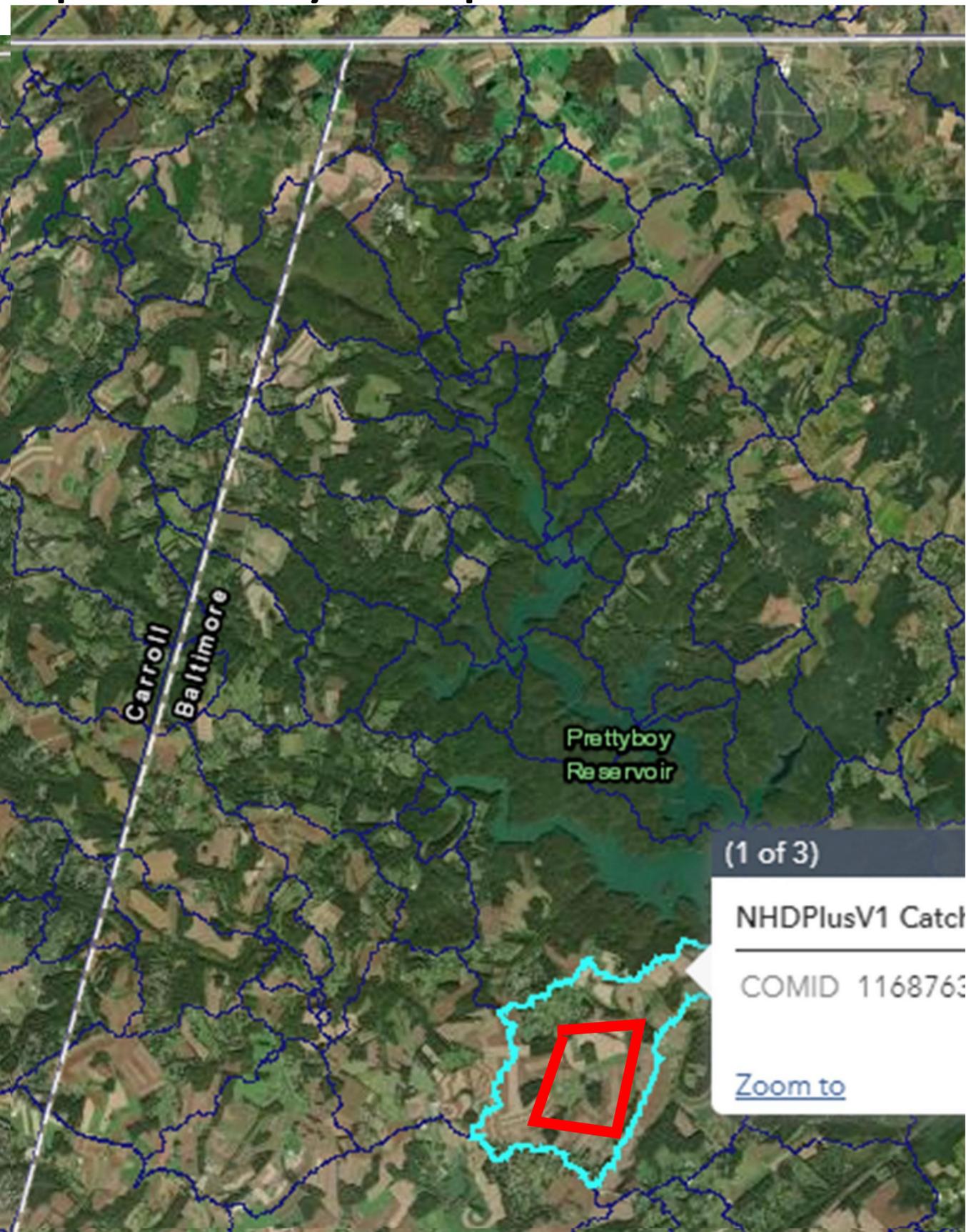
- Greater accuracy
  - Increased calibration stations
  - Finer process representation leads to more accuracy at a decision scales
- Enables fine scale targeting of practices for greater management efficiency
- Potentially bring in more local users
- Needed for some co-benefits

# Spatially Explicit CAST



- Allow calculation of load from within user-defined area
- based on **land-river segment** averages applied to the land uses in the area

# Spatially Explicit CAST with Fine-Scale Modeling



- Allow calculation of load from within user-defined area
- based on **NHD or finer segment** averages applied to the land uses in the area

# Physical Process Improvement

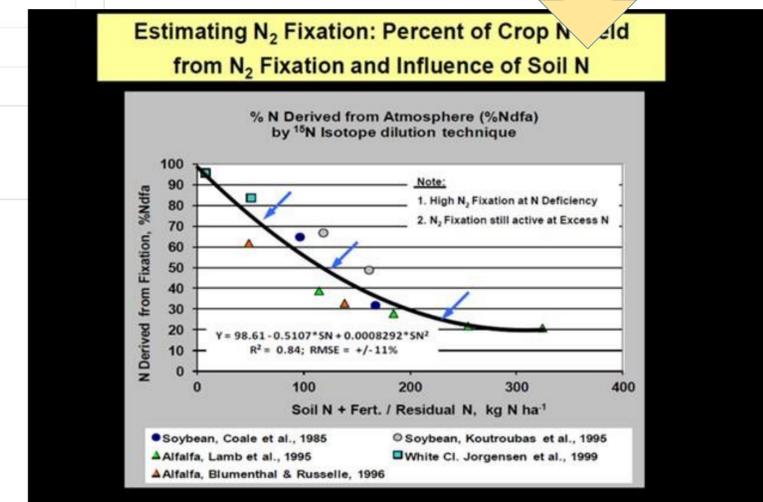
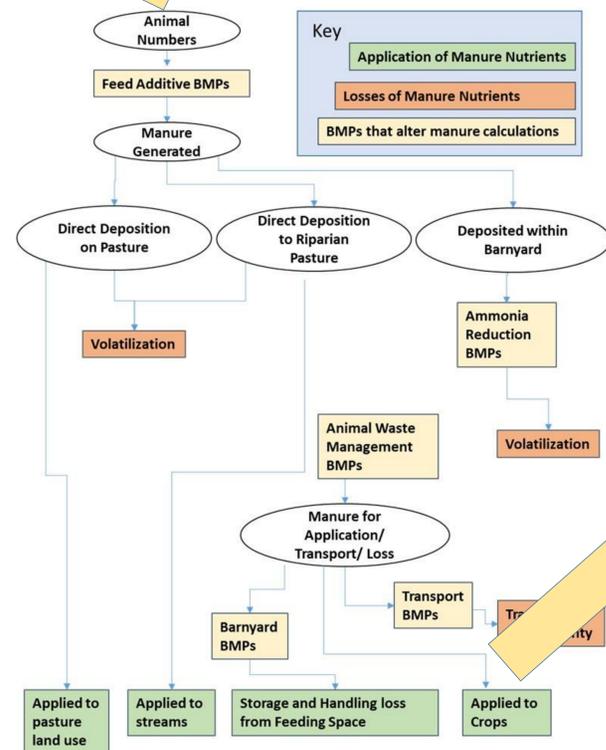
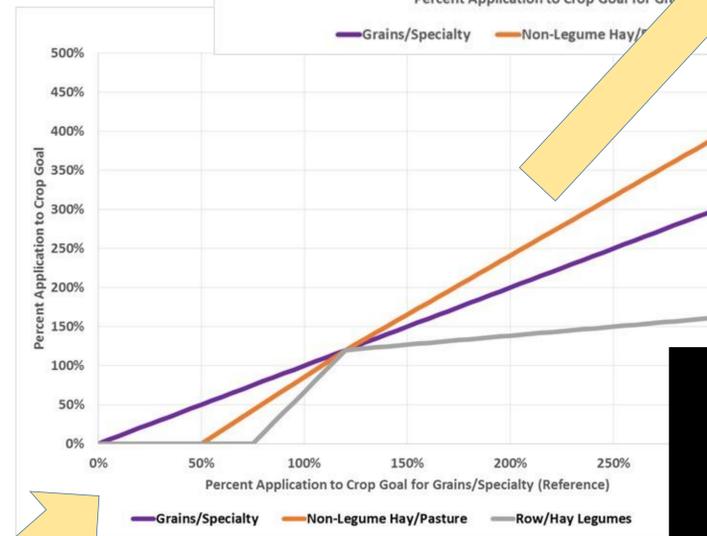
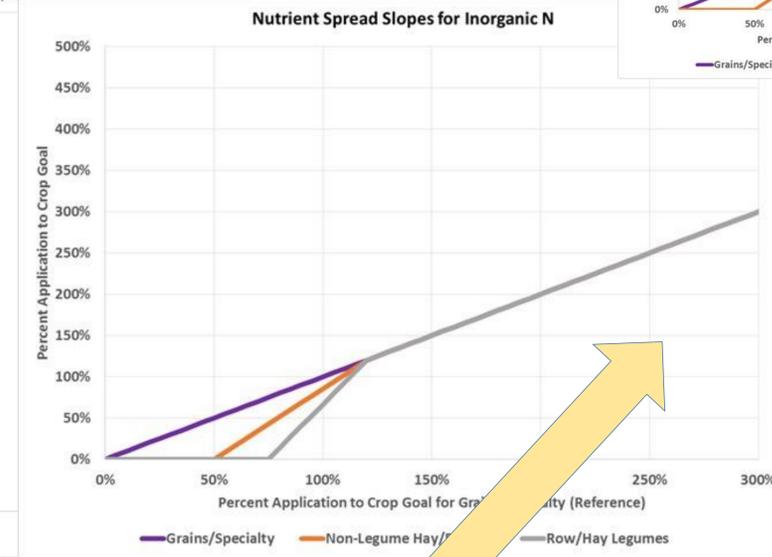
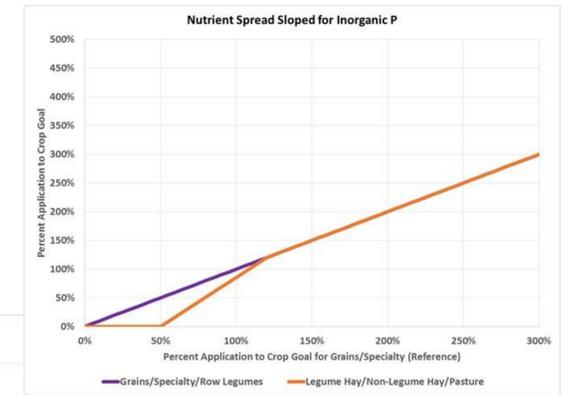
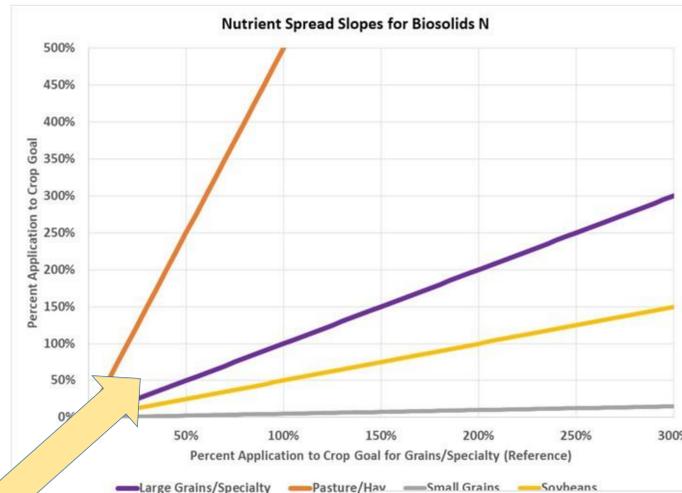
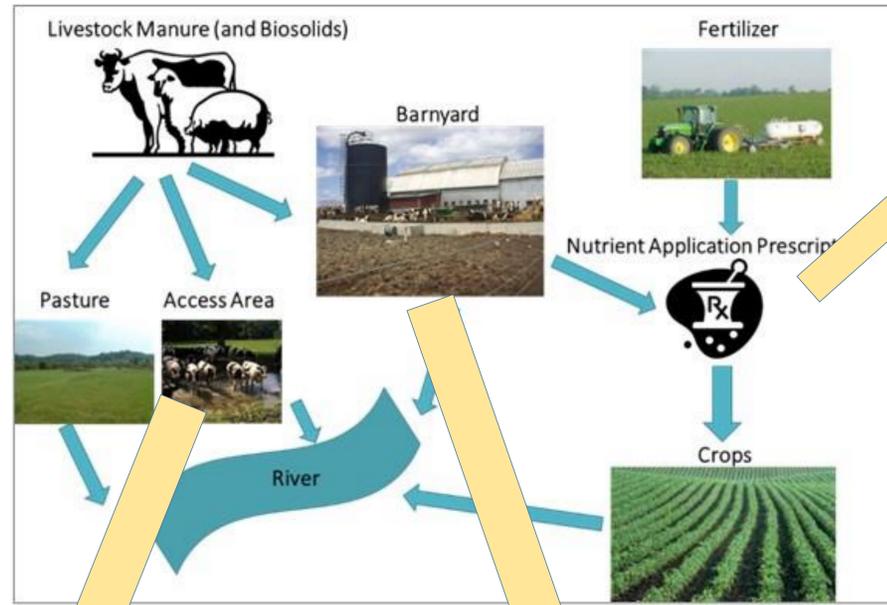
- Phosphorus simulation in urban areas
  - Only watershed modeling need identified in the STAR SRS science needs database
  - Fertilizer applications
  - Development on prior farmland
- Sediment Processes
  - Important for understanding nutrient lag times.
  - Affects health of non-tidal streams
- Stream bed and bank loads
  - Partnership wanted them broken out from land use loads for P6
  - Causing some confusion when natural category changes due to management actions in other category.

# Physical Process Improvement

- Change in load due to change in input (sensitivities)
- Temperature simulation at fine scale
  - Impacts co-benefits
- Nutrient speciation
  - Allow for targeting management that reduces inorganics

# Nutrient Applications

To be prioritized



# Simulated BMPs vs Percent Reduction

- **Which Description Works Best for Management?**
- **What's my reduction from Nutrient Management?**
  - Well, based on the rules developed by the partnership and the data supplied by national sources and the states, the balance of inputs and outputs for your land use is such that there is an overabundance of manure in your county, as opposed to the next county over where nutrient management has almost no effect. Now when you apply nutrient management, that will attract manure to the nutrient management land use, so it will have a higher load, but since it's pulling manure from other land uses, the total segment load will usually decrease, however in some circumstances when nutrient management is applied to pasture, it can push so much manure back on to other land uses, that the marginal effect ...
- **What's my reduction from Cover Crops?**
  - Based on the Cover Crop Panel, who based their decision on multiple referenced data sources and models, your reduction for Early Drilled Barley in the Valley and Ridge Carbonate region is 38%

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# WQ Standards Assessment

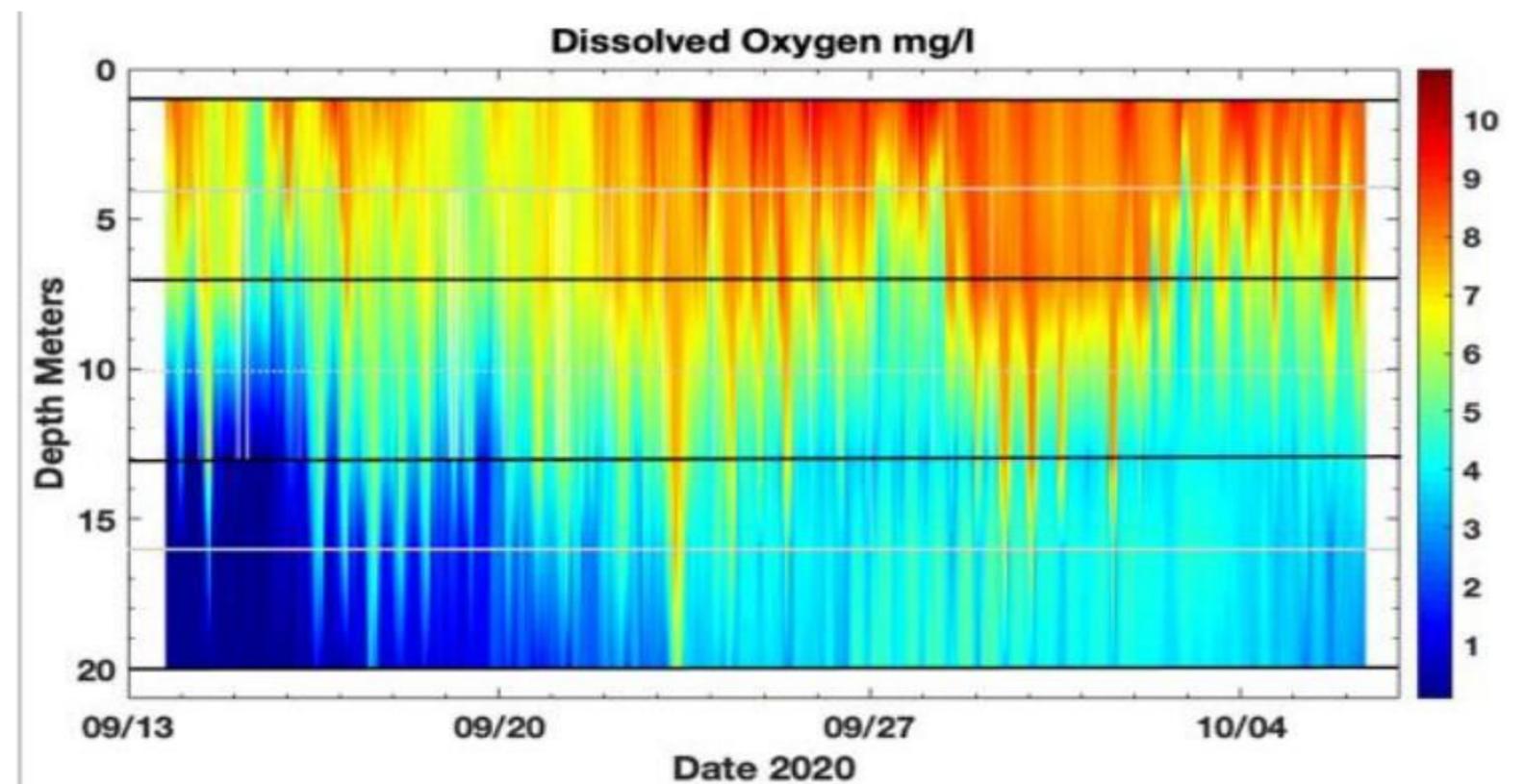
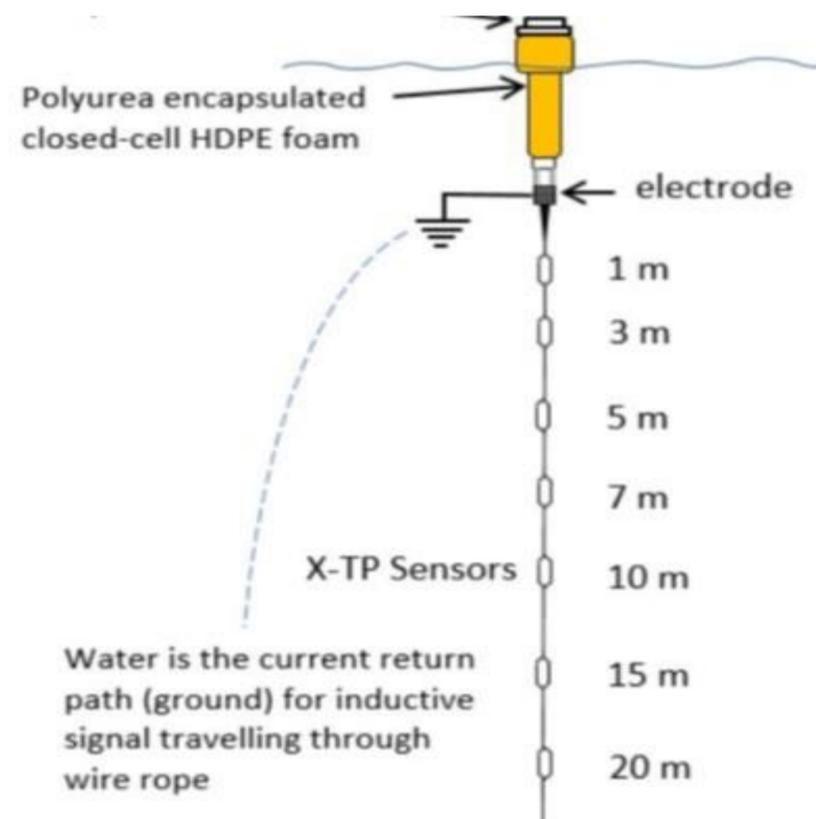
INDICATOR Water Quality Standards Attainment Assessment for Chesapeake Bay DO, Water Clarity and Chlorophyll a

Bay Attainment	Segments <sup>1</sup>	Designated Uses <sup>2</sup>	Criteria	Season	Thresholds
Bay Attainment	1 Segment 2 Segment 45 Segment 46 Segment 47 Segment 91 Segment 92 Segment	Migratory	DO	Feb-May	30-day mean <sup>6</sup> instantaneous minimum
		Open Water	DO	June-Jan <sup>3</sup>	TF= 30 day mean; OH-PH 30 day mean 7-day mean instantaneous minimum
				June-Sept	TF= 30 day mean; OH-PH 30 day mean 7-day mean instantaneous minimum
		Deep Water	DO	Spring	TF <sub>10</sub> =10 TF <sub>15</sub> =15 OH=15 MH=12 PH=12
				Summer	TF <sub>10</sub> =25 TF <sub>15</sub> =23 OH=22 MH=10 PH=10; DC = 25
		Deep Channel	DO	June-Sept	30 day mean 1-day mean instantaneous minimum
				Oct-May	TF= 30 day mean; OH-PH 30 day mean 7-day mean instantaneous minimum
		Shallow water Bay grasses	DO	June-Sept	Dependent upon Open Water attainment assessment
				Water Clarity/SAV	SAV season

Currently only able to assess 8 of 22 standards

No segment can currently be taken off the TMDL 303d list for all relevant criteria

# WQ Standards Assessment



- Need monitoring and modeling team working together on developing replacement for CBP interpolator
- Represent spatial and temporal variance
- Expand to shallow areas
- Integrate with models

# Co-Benefits and Ecosystem Services

- CAST currently generates N, P, S, and cost based on land use, management actions and wastewater loads.
- Co-Benefits are other CBP outcomes that could be affected by BMP implementation
  - Fish Habitat
  - Brook Trout
  - Tree canopy ...
- Ecosystem Services are anything that have a value to people
  - Carbon sequestration
  - Scenic Views ...
- Adding Co-Benefits would account for non-TMDL incentives to implementation

# Co-Benefits and Ecosystem Services

- Develop and integrate models of living resource response
  - Literature reviews
  - Coordination with academic and federal researchers
- Examples
  - Models of striped bass habitat squeeze
  - Vibrio
  - Harmful algal blooms

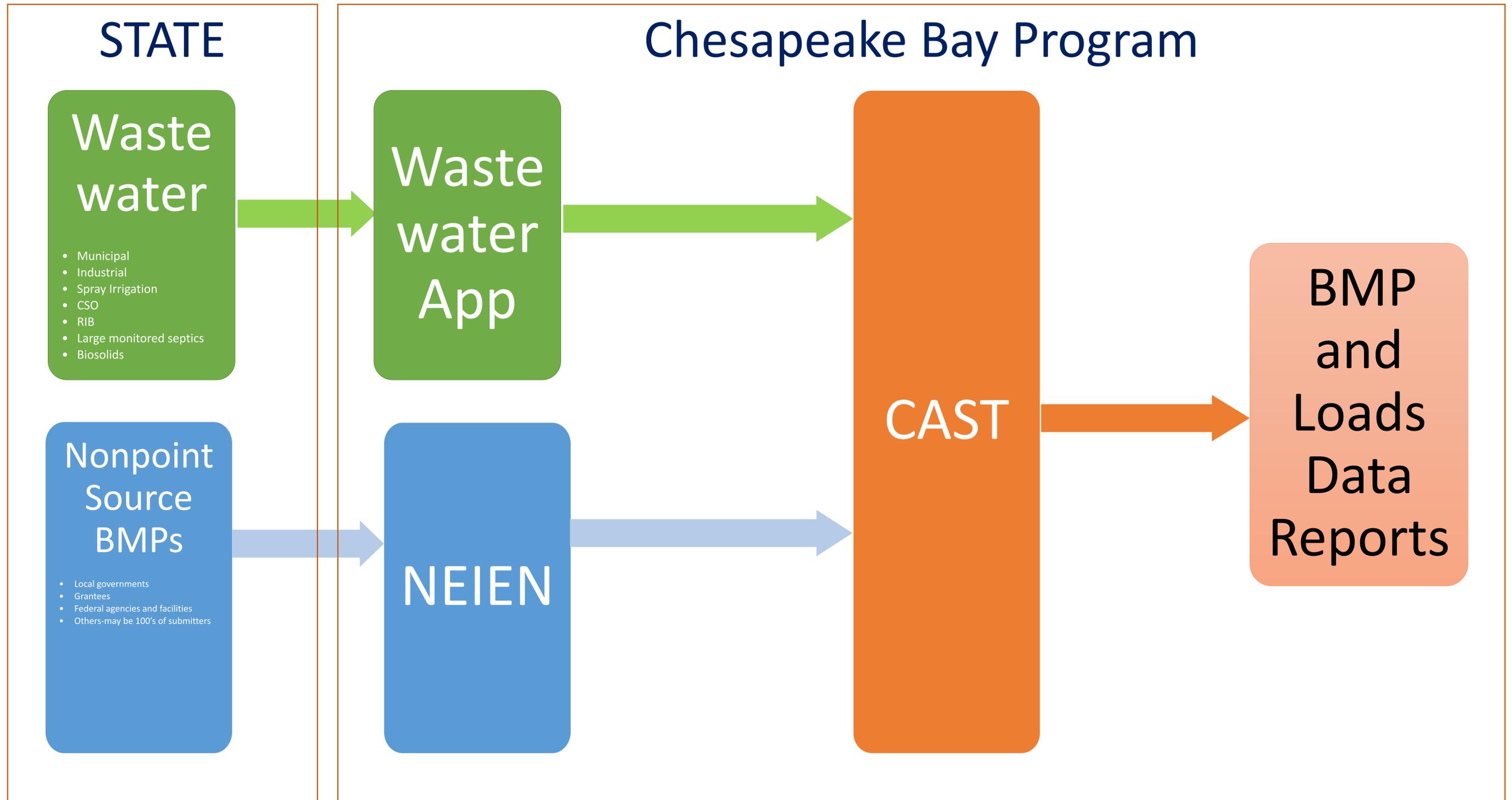
# Uncertainty Quantification

- Answers to the questions
  - How certain are we that we are getting the reductions we estimate?
  - What parts of the model have the largest impact on the nutrient load estimation?
- AgWG requested uncertainty quantification in Phase 6 review

# Improve Climate Change Modeling

- Only task specifically given by PSC
- Thoroughly dealt with in the watershed model in 2019
- Some improvements are still possible
- Changes in BMP effectiveness estimates may be out of reach

# Transparency in NEIEN/CAST Progress data



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