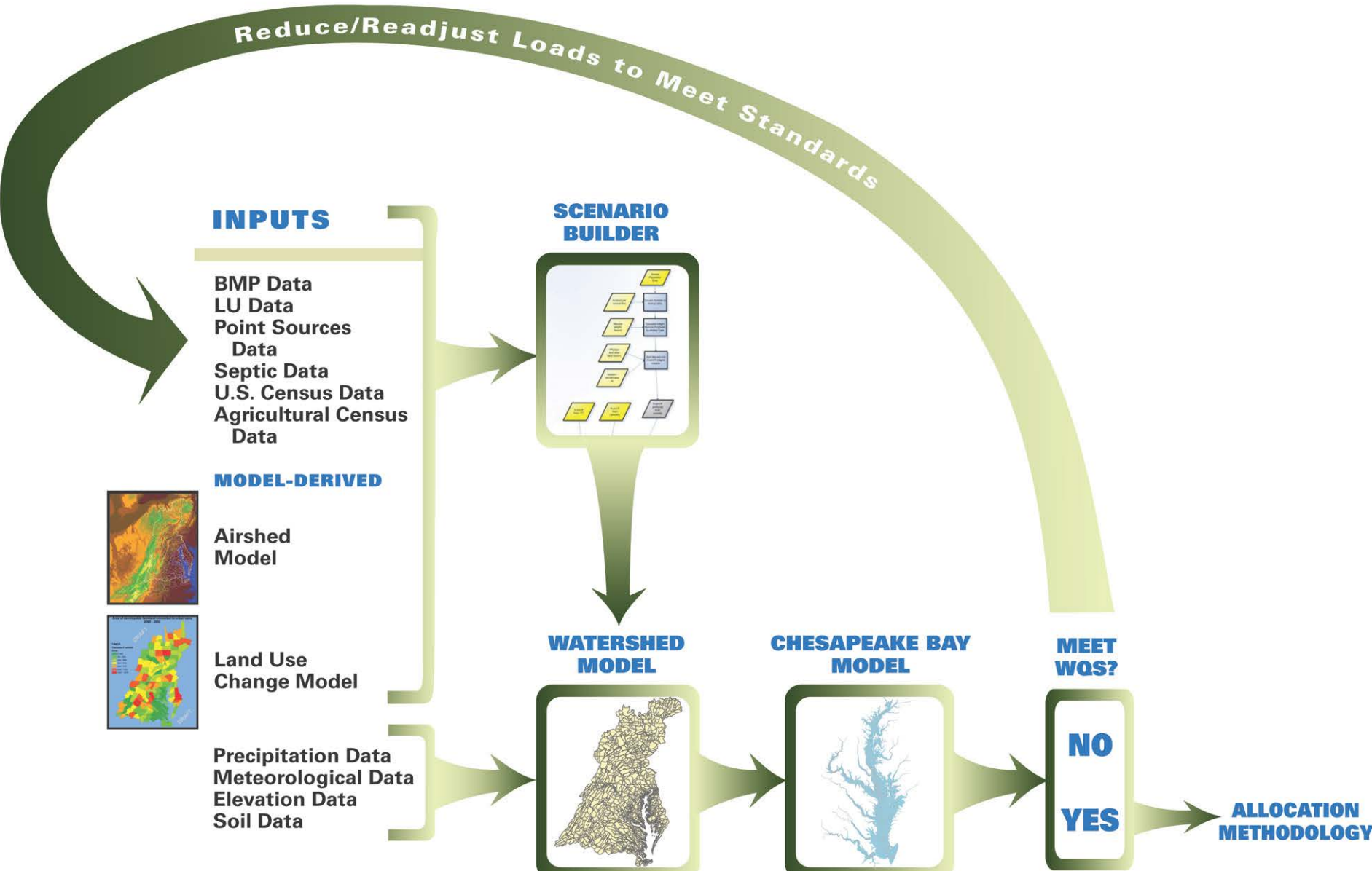


# The Chesapeake Bay Program's Decision Support Tools

Gary Shenk

5/21/2013

# Chesapeake Bay Partnership Models



# CBP Modeling Tools

Interaction  
Tools



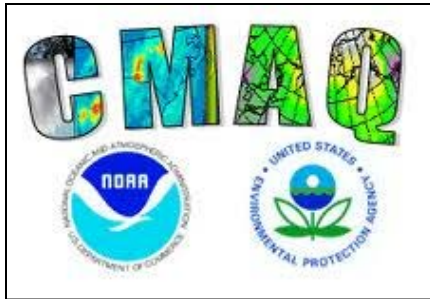
# CAST



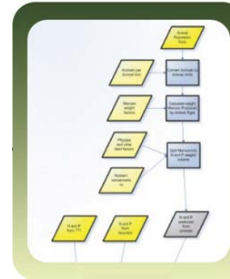
Decision  
Models/  
Databases



Land Use  
Change Model



**SCENARIO  
BUILDER**



**WATERSHED  
MODEL**

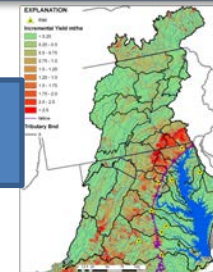


Bay  
WQSTM












Related  
Tools

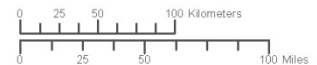
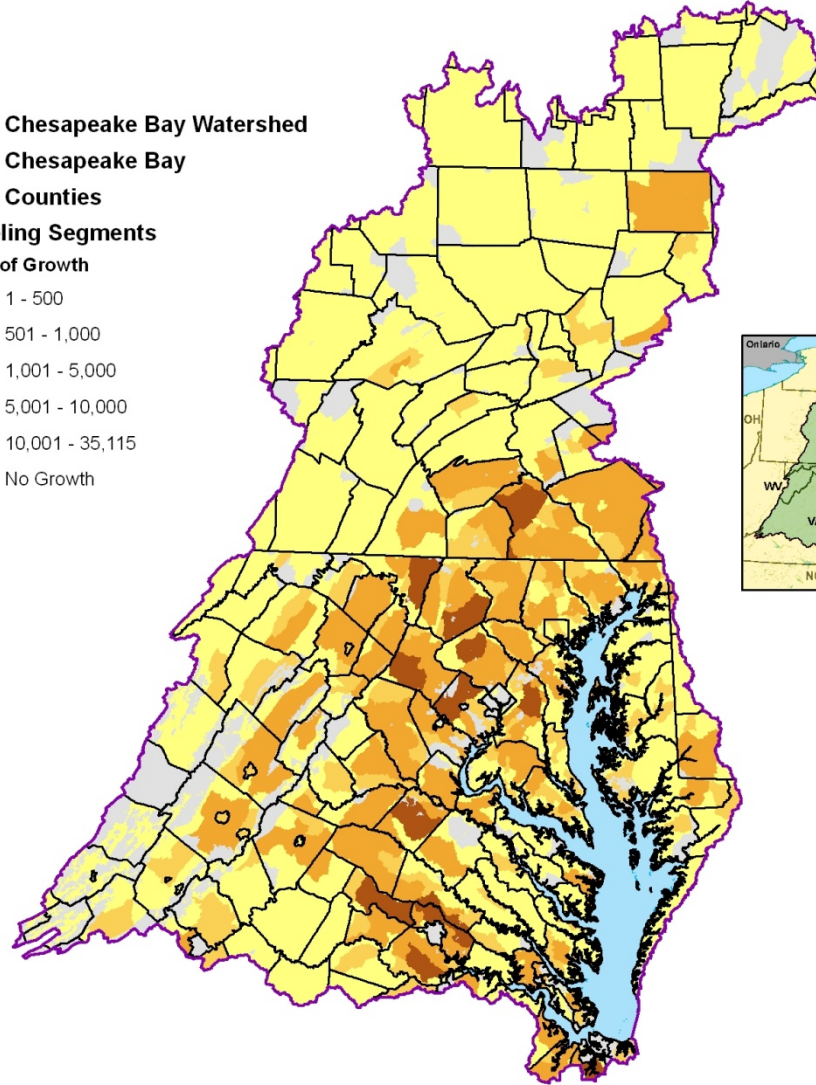
sparrow



# Forecasted Urban Growth in the Chesapeake Bay Watershed Trend Scenario (2006 - 2025)



-  Chesapeake Bay Watershed
-  Chesapeake Bay
-  Counties
- Modeling Segments**
- Acres of Growth**
-  1 - 500
-  501 - 1,000
-  1,001 - 5,000
-  5,001 - 10,000
-  10,001 - 35,115
-  No Growth

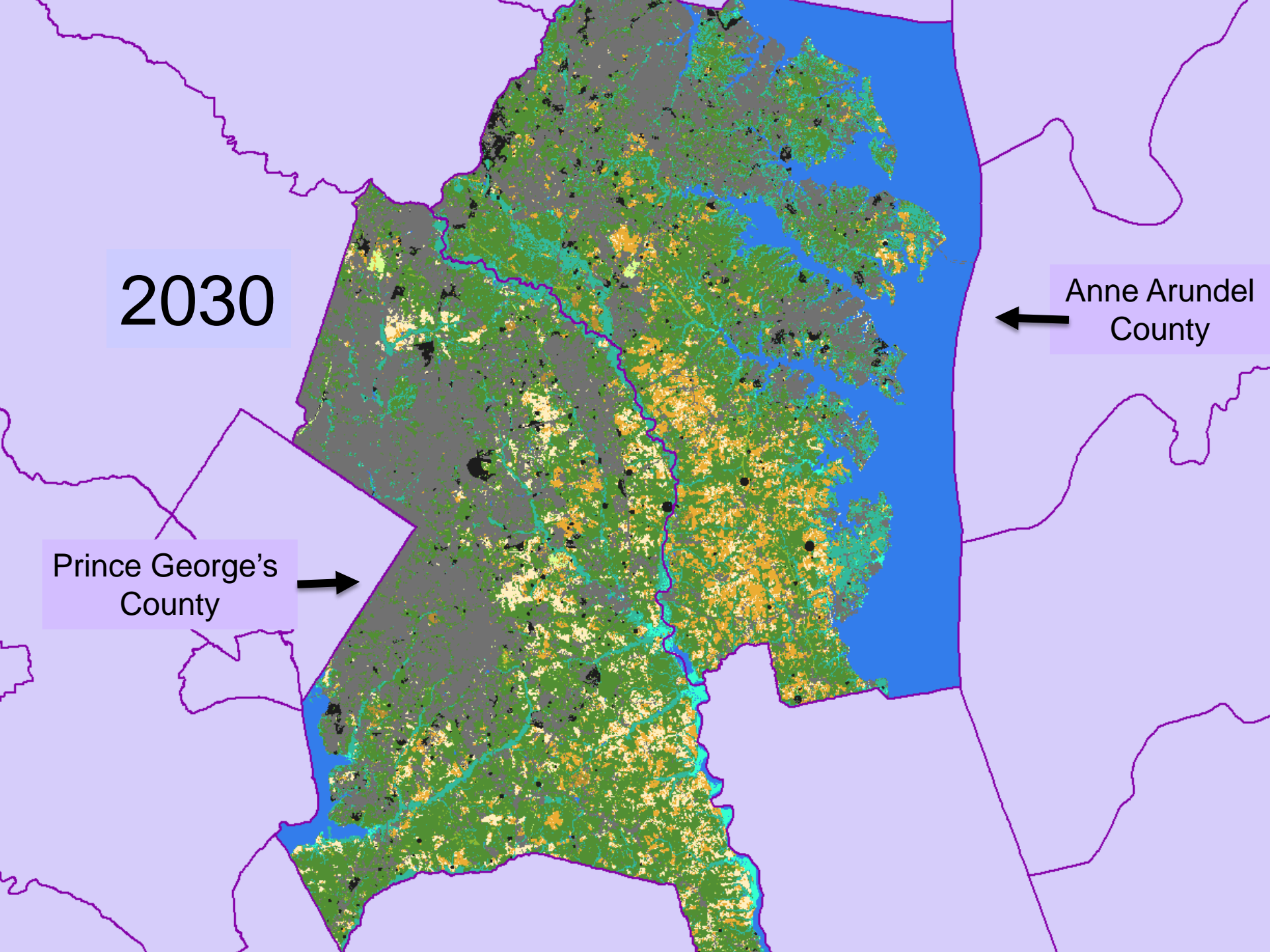


2030

Prince George's  
County

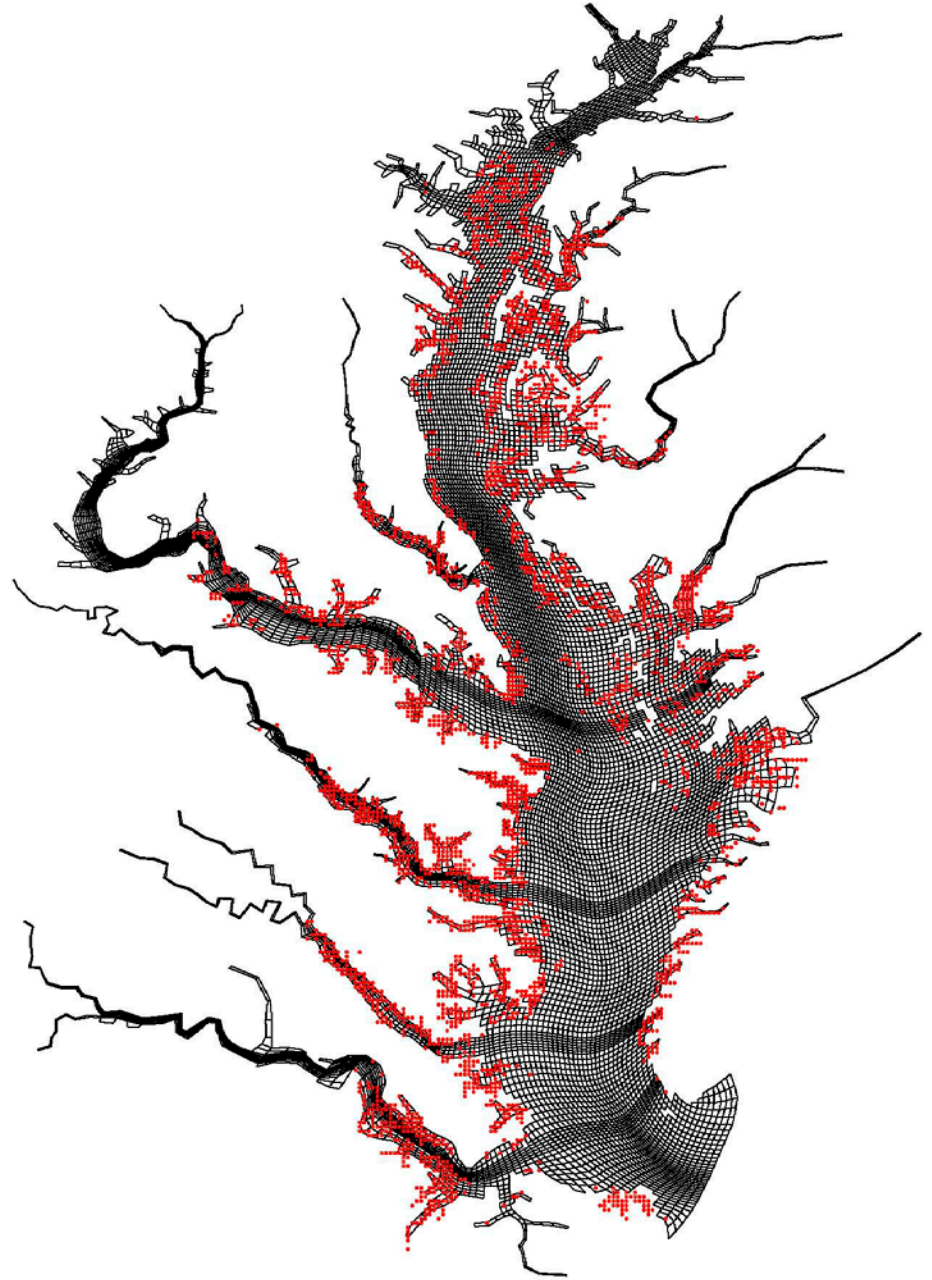


Anne Arundel  
County



# Estuarine Model

- 57,000 cells
- sub-hour hydrodynamics
  
- CH3D
- CEQUAL-ICM



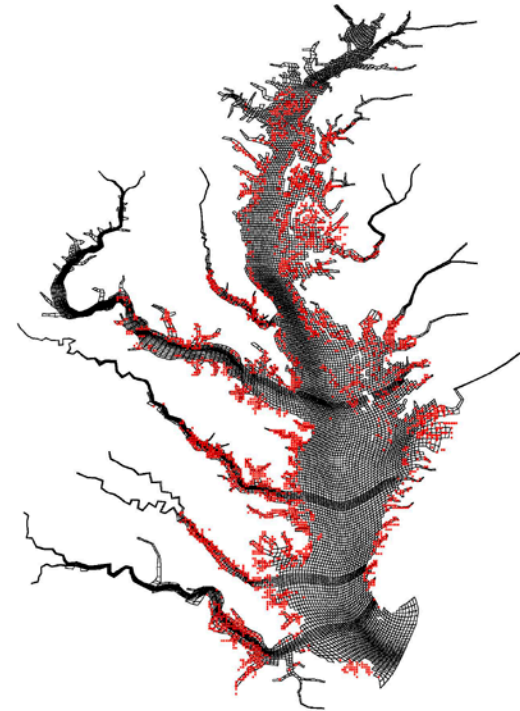
Water Quality Model State Variables	
Temperature	Salinity
Fixed Solids	Freshwater Cyanobacteria
Spring Diatoms	Other (Green) Algae
Microzooplankton	Mesozooplankton
Dissolved Organic Carbon	Labile Particulate Organic Carbon
Refractory Particulate Organic Carbon	Ammonium
Nitrate+Nitrite	Dissolved Organic Nitrogen
Labile Particulate Organic Nitrogen	Refractory Particulate Organic Nitrogen
Total Phosphate	Dissolved Organic Phosphorus
Labile Particulate Organic Phosphorus	Refractory Particulate Organic Phosphorus
Chemical Oxygen Demand	<b>Dissolved Oxygen</b>
Dissolved Silica	Particulate Biogenic Silica

## Living Resources Outputs

SAV

Oysters

Menhaden



# Estuarine Model

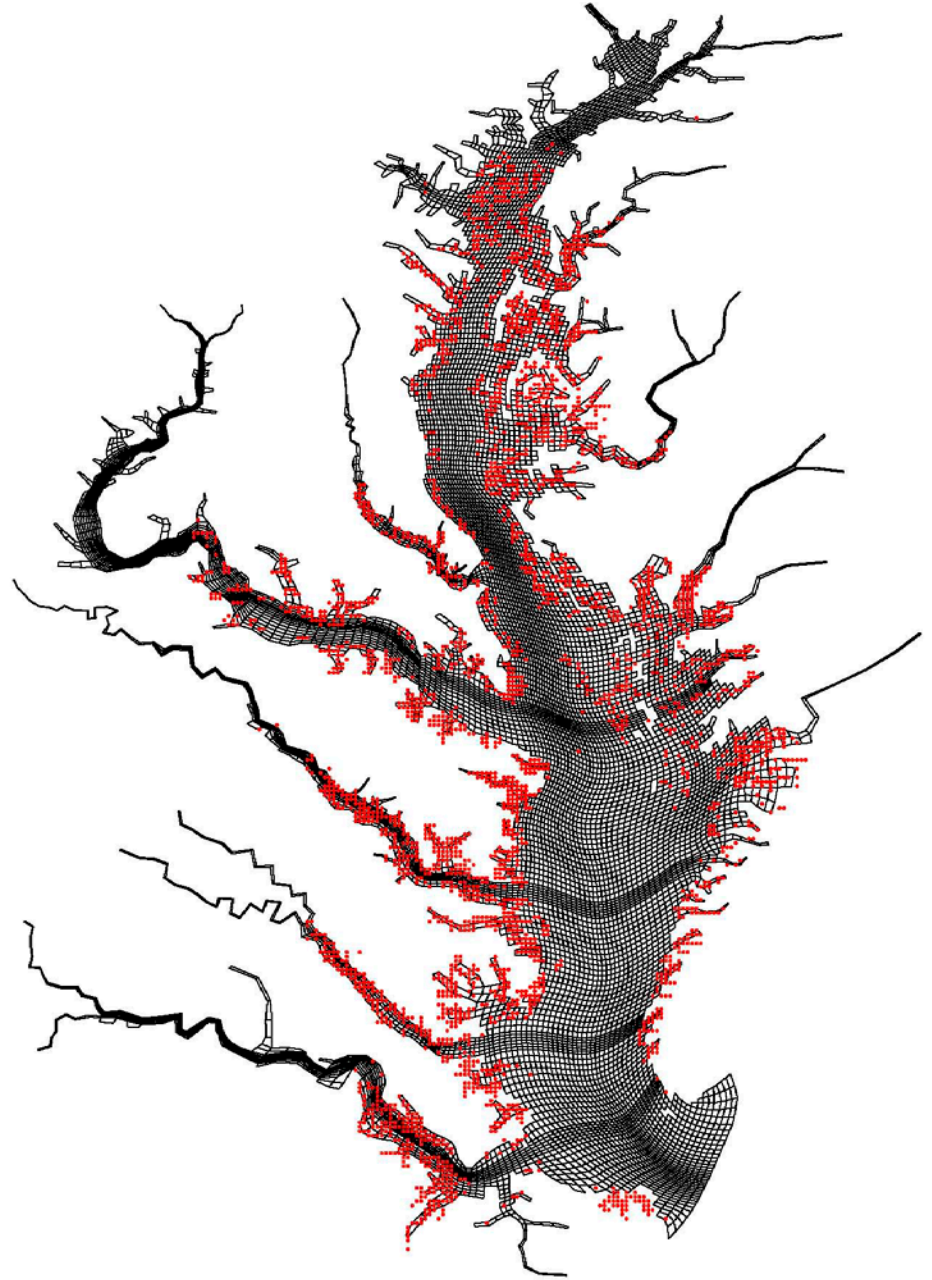
## Decision variables

Dissolved Oxygen

Clarity

Submerged Aquatic Vegetation

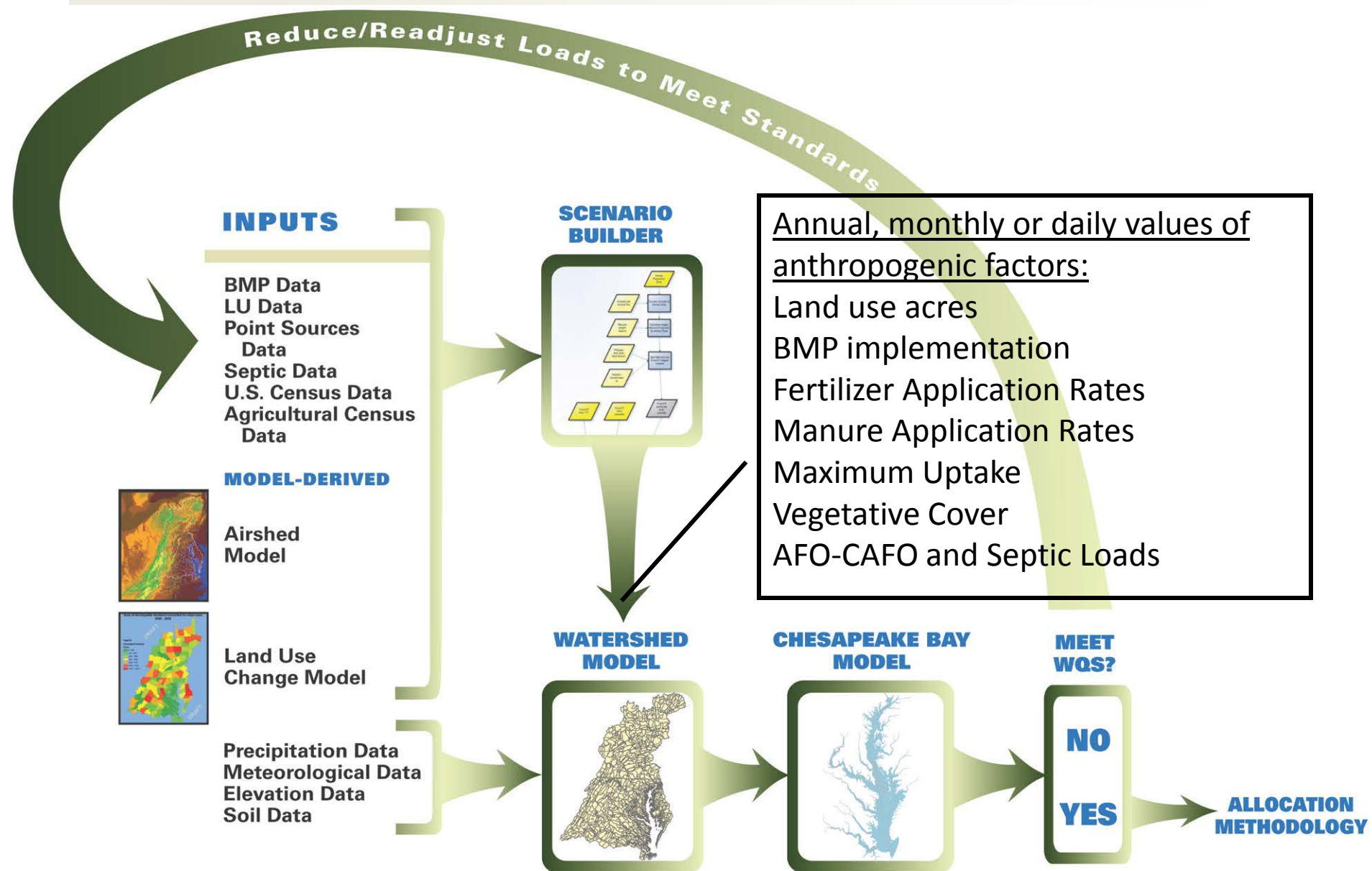
Chlorophyll concentrations







# Role of the Bay Partnership Models In Decision-Making



# How the Watershed Model Works

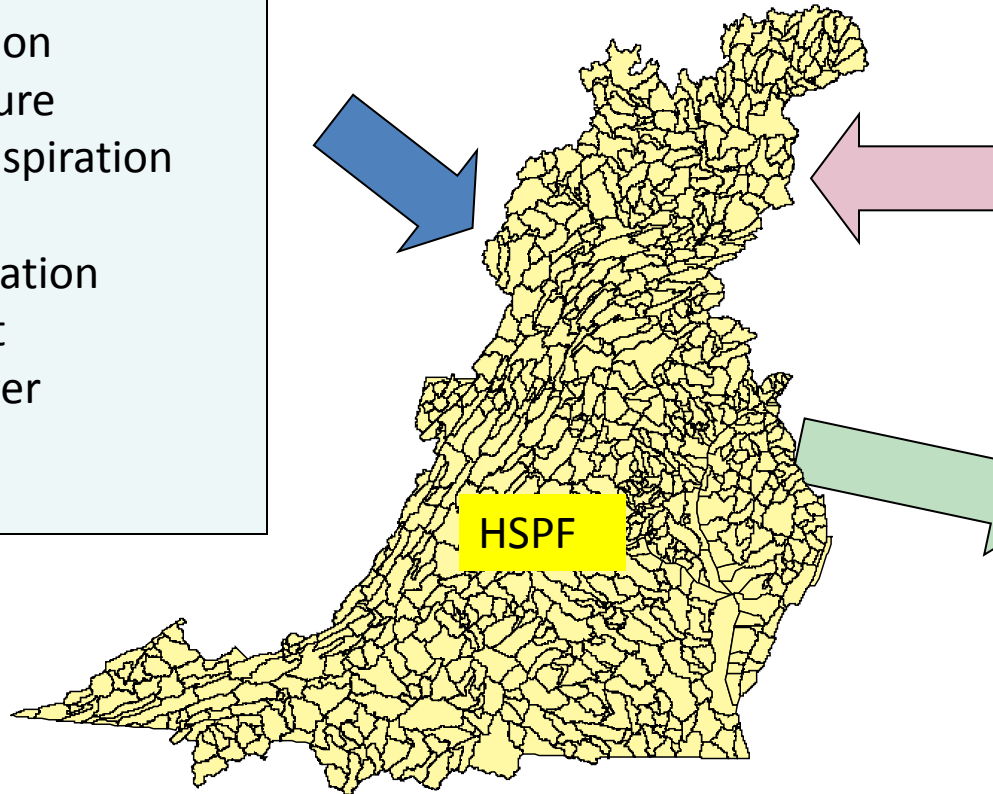
## Calibration Mode

Hourly or daily values of  
**Meteorological factors:**

Precipitation  
Temperature  
Evapotranspiration  
Wind  
Solar Radiation  
Dew point  
Cloud Cover

Annual, monthly, or  
daily values of  
**anthropogenic factors:**

Land Use Acreage  
BMPs  
Fertilizer  
Manure  
Tillage  
Crop types  
Atmospheric deposition  
Waste water treatment  
Septic loads



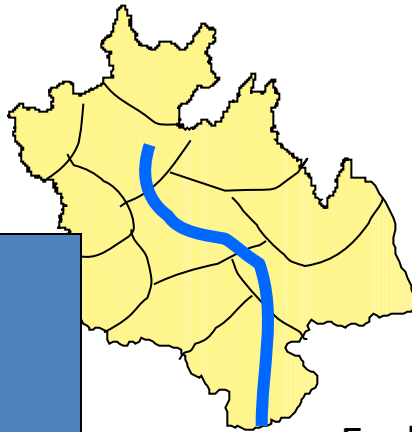
Daily flow, nitrogen,  
phosphorus, and  
sediment compared  
to observations  
over 21 years

# How the Watershed Model Works

Each segment consists of 30 separately-modeled land uses:

- Regulated Pervious Urban
- Regulated Impervious Urban
- Unregulated Pervious Urban
- Unregulated Impervious Urban
- Construction
- Extractive
- Combined Sewer System
- **Wooded / Open**
- **Disturbed Forest**

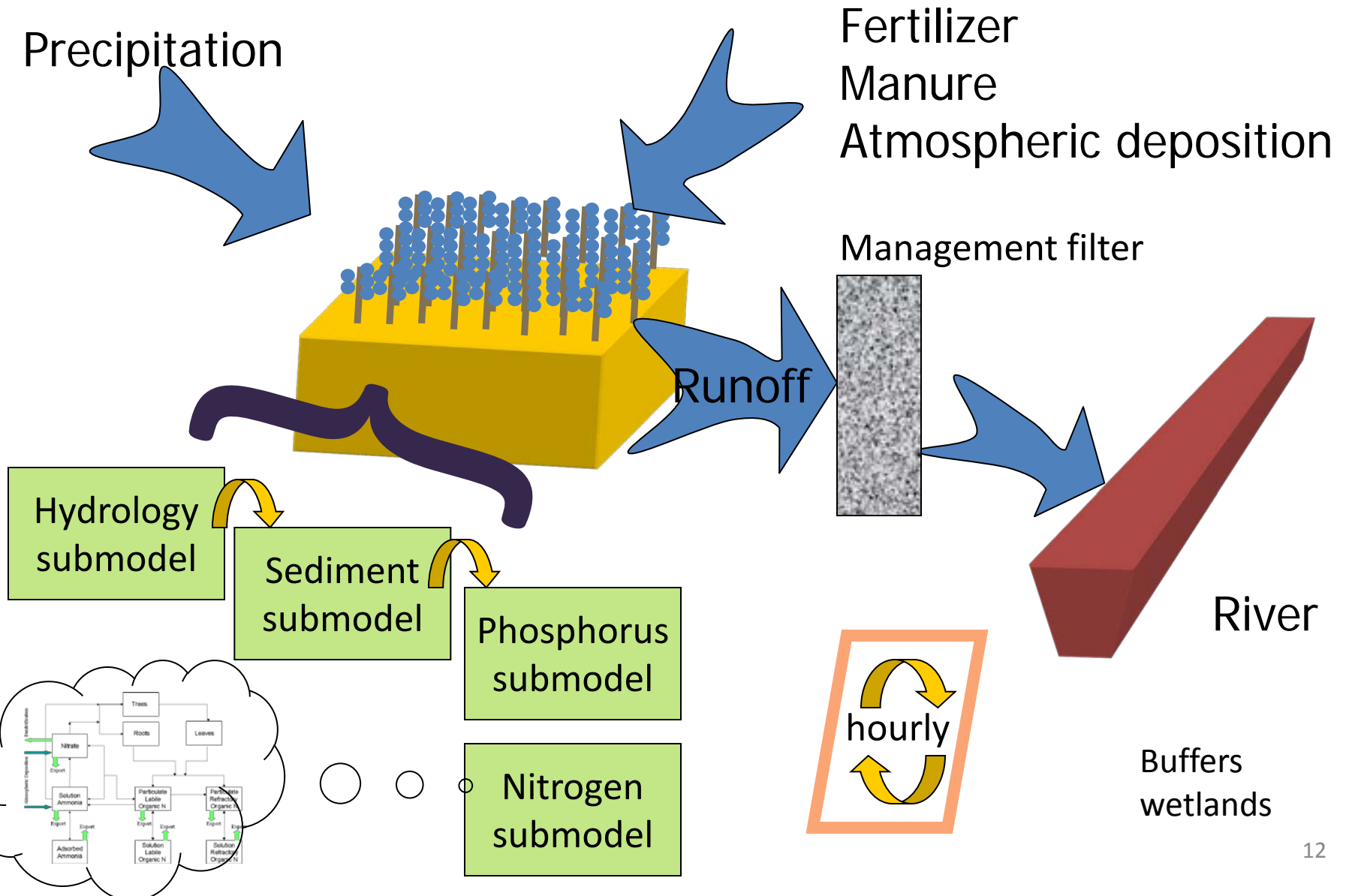
- **Corn/Soy/Wheat rotation (high till)**
- **Corn/Soy/Wheat rotation (low till)**
- **Other Row Crops**
- **Alfalfa**
- **Nursery**
- **Pasture**
- **Degraded Riparian Pasture**
- **Afo / Cafo**
- **Fertilized Hay**
- **Unfertilized Hay**
  - **Nutrient management versions of the above**



Plus: Point Source and  
Septic Loads, and  
Atmospheric  
Deposition Loads

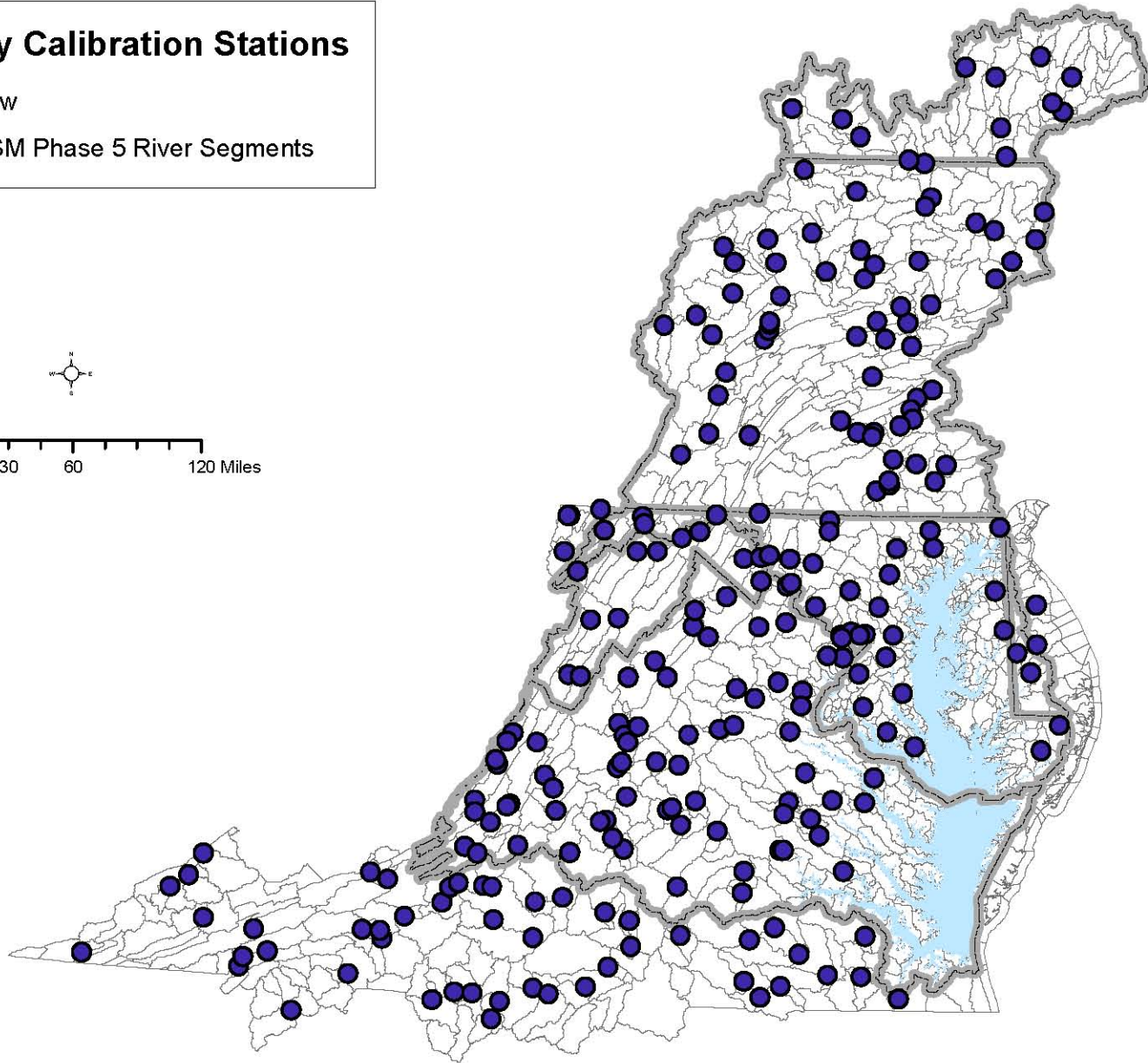
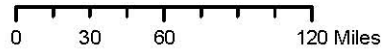
Each calibrated to nutrient and  
Sediment targets

# How the Watershed Model Works



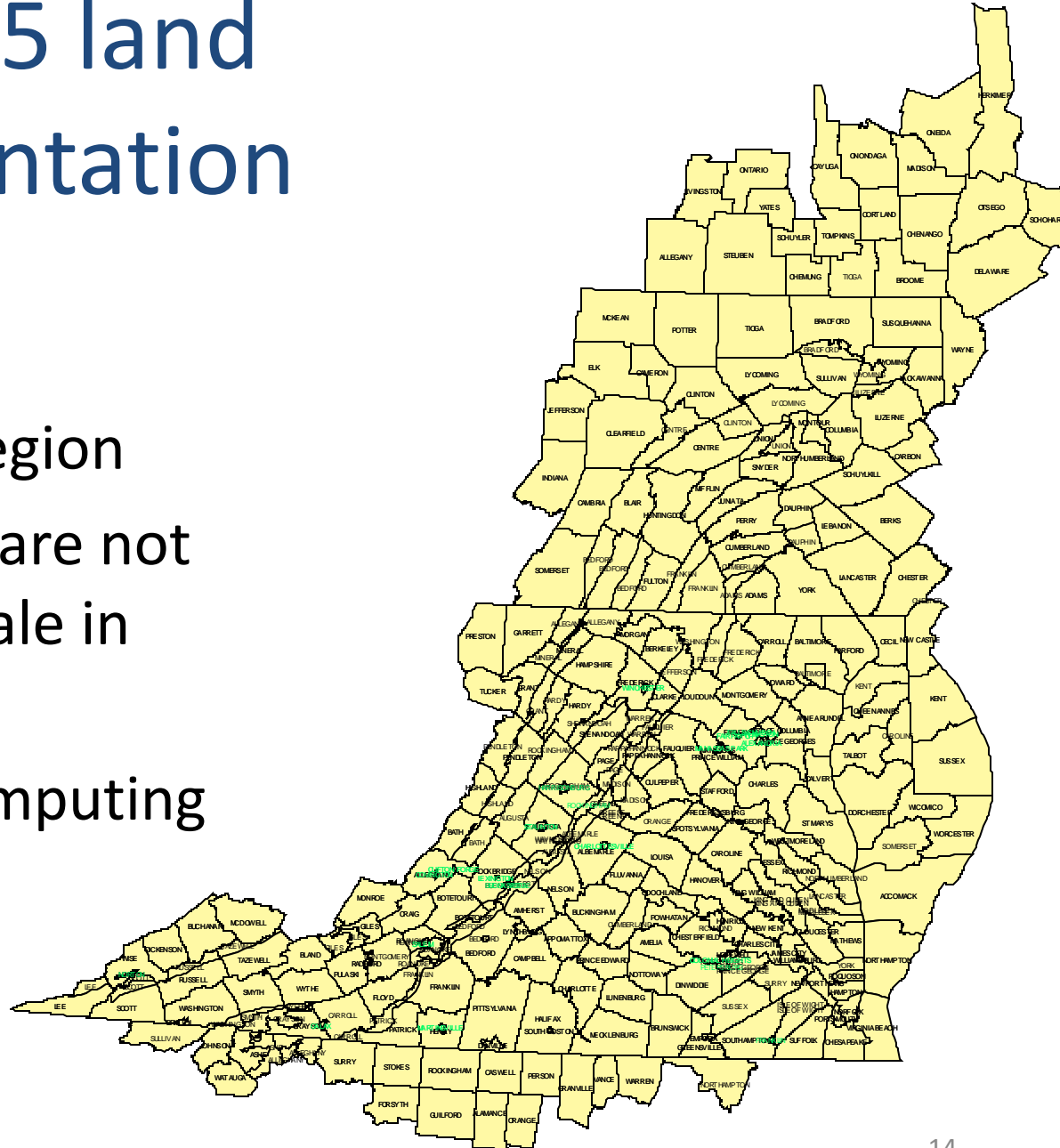
# Hydrology Calibration Stations

- Flow
- WSM Phase 5 River Segments



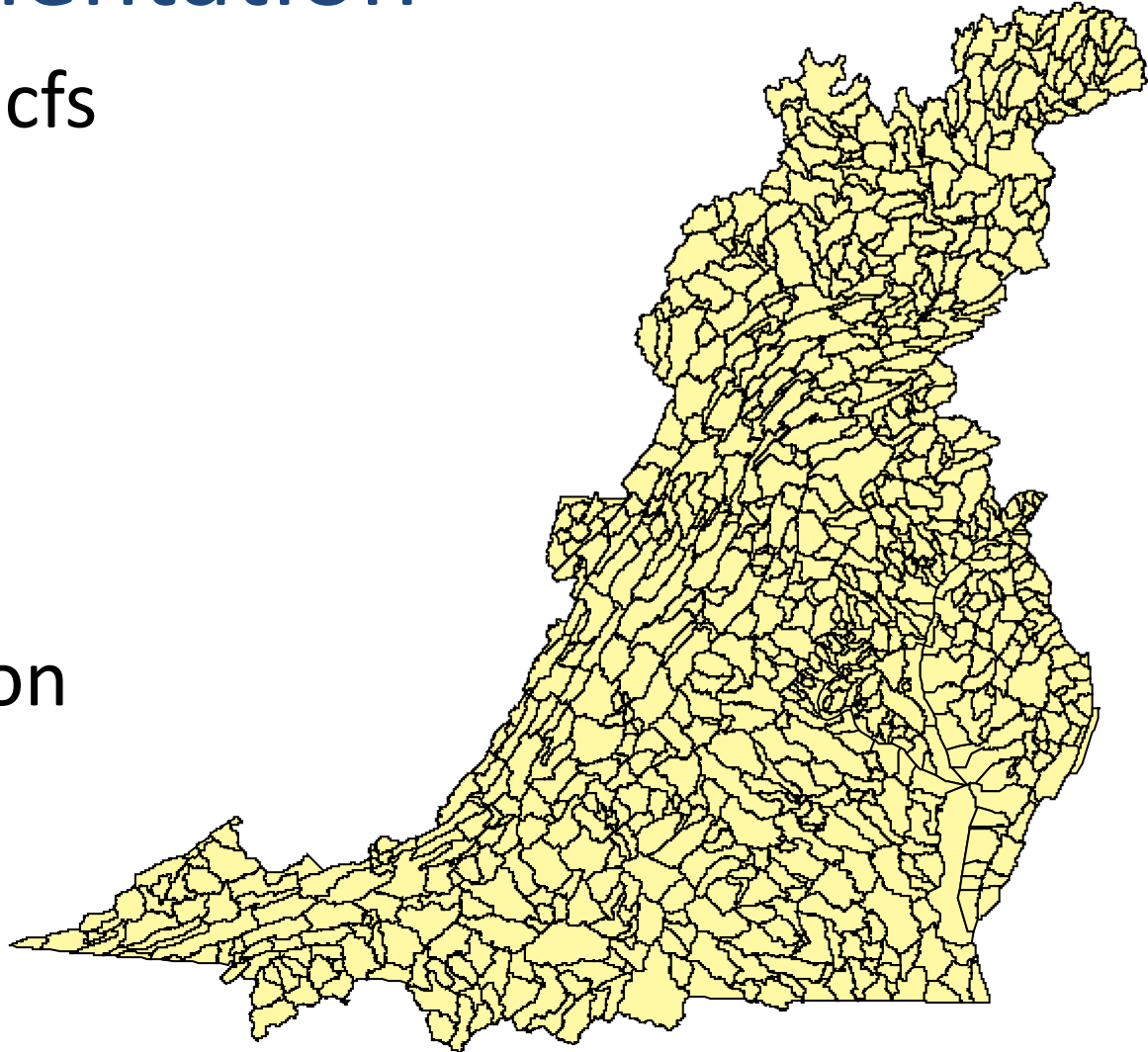
# Phase 5 land segmentation

- Most counties are completely within a hydrogeomorphic region
- BMP and Crop data are not known on a finer scale in most cases
- Near the limit of computing capacity



# Phase 5 River Segmentation

- Greater than 100 cfs  
or
- Has a flow gage
- Near the limit of meaningful data
- Consistent criterion



# How the Watershed Model Works

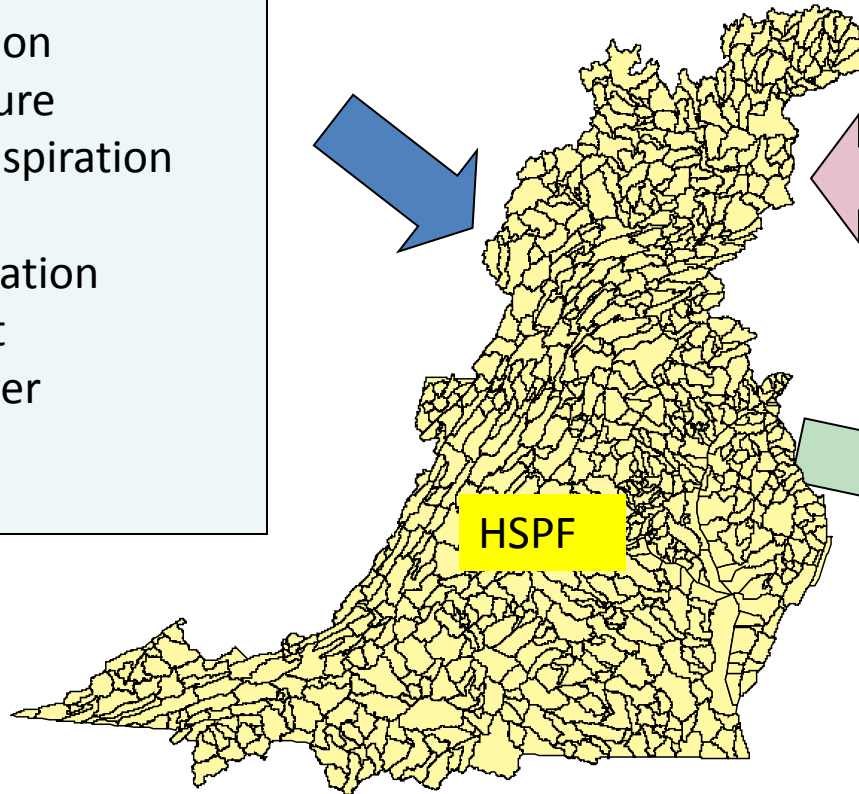
## Scenario Mode

**Hourly or daily values of Meteorological factors:**

Precipitation  
Temperature  
Evapotranspiration  
Wind  
Solar Radiation  
Dew point  
Cloud Cover

**Snapshot of anthropogenic factors:**

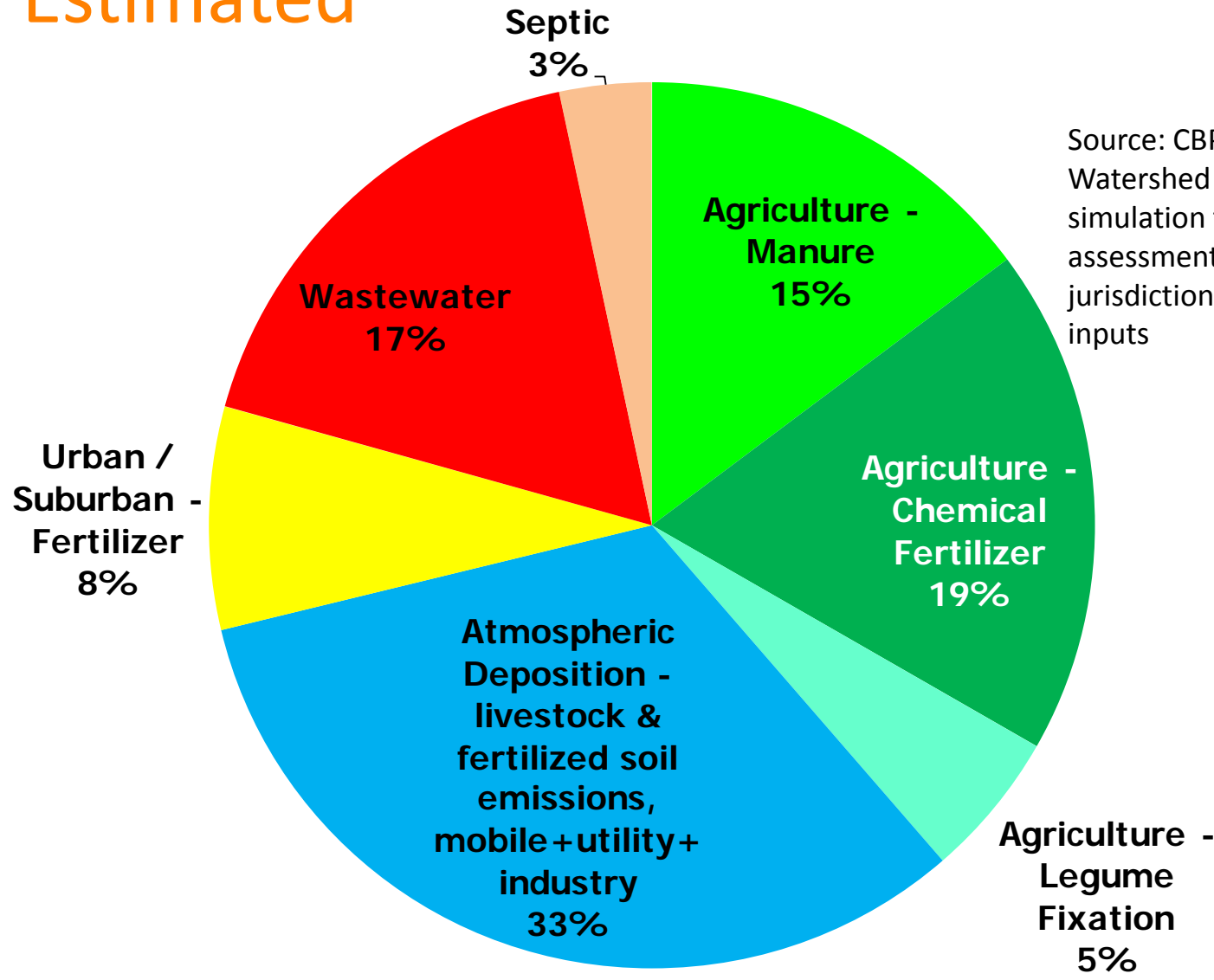
Land Use Acreage  
BMPs  
Fertilizer  
Manure  
Tillage  
Crop types  
Atmospheric deposition  
Waste water treatment  
Septic loads



Flow-normalized loads

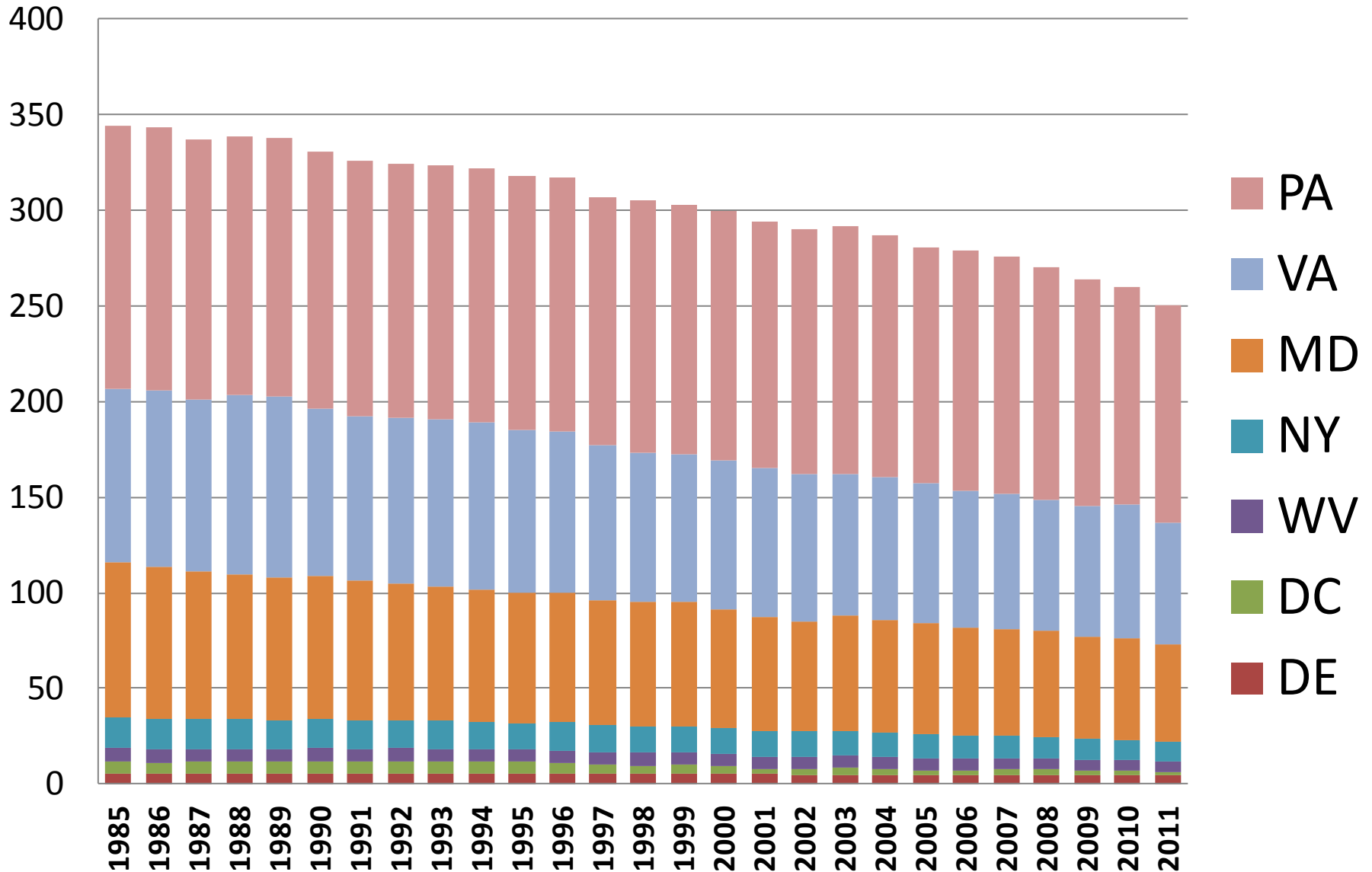


# Nitrogen Loads to the Chesapeake Bay 2012 Estimated

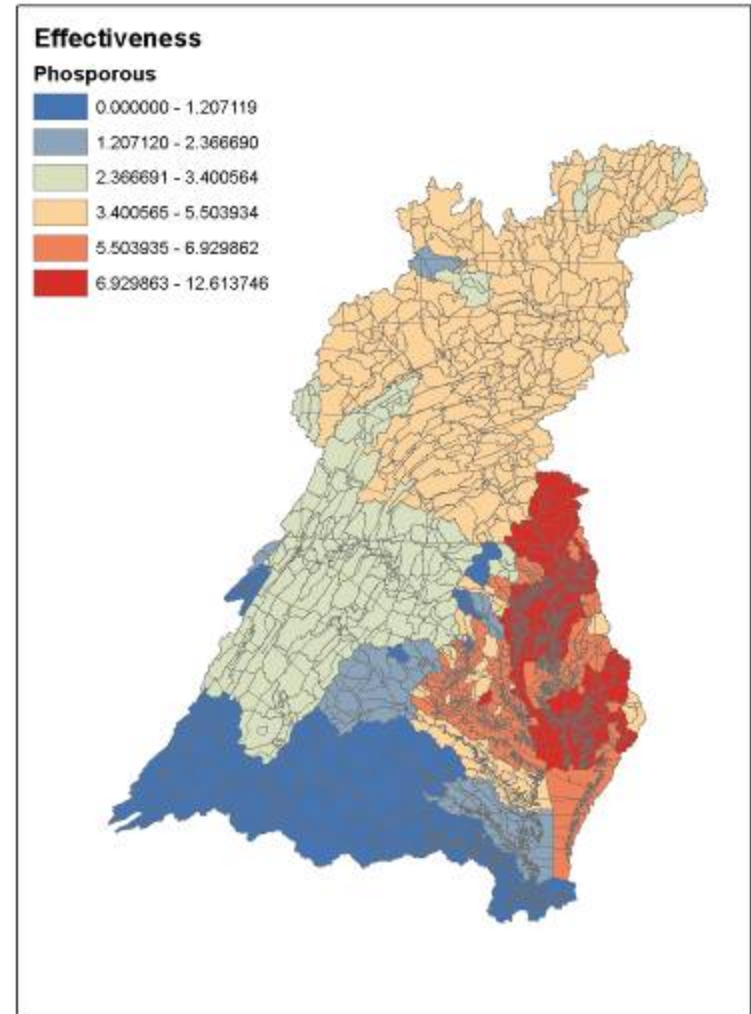
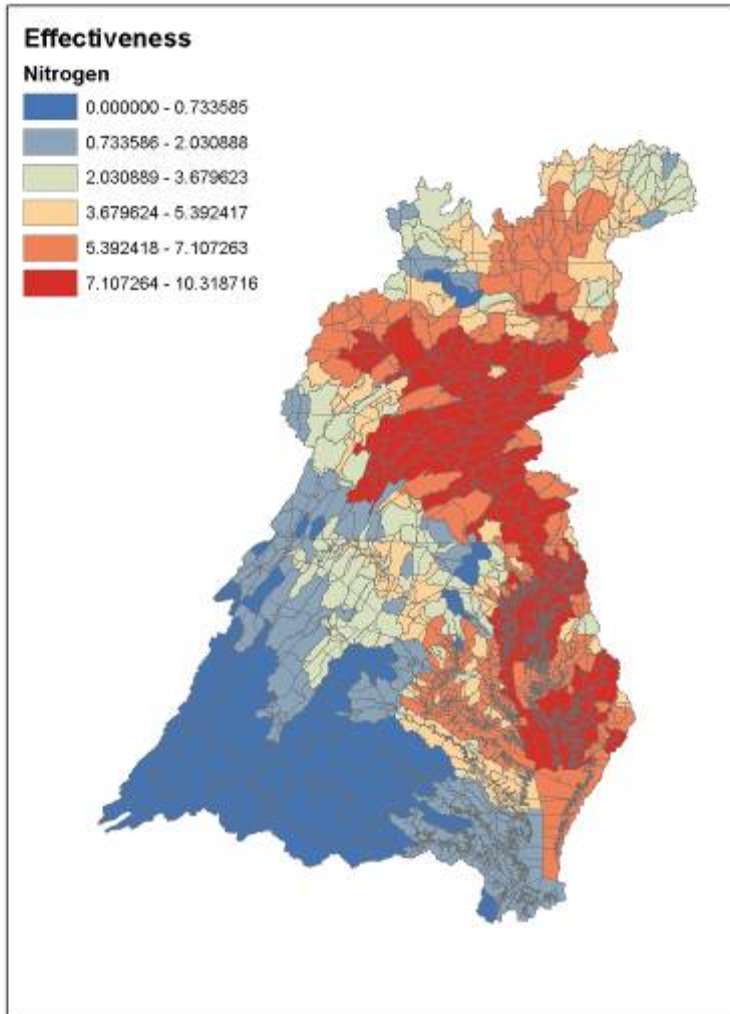


Source: CBP Phase 5.3.2 Watershed Model data and simulation for 2012 assessment including jurisdictional supplied inputs

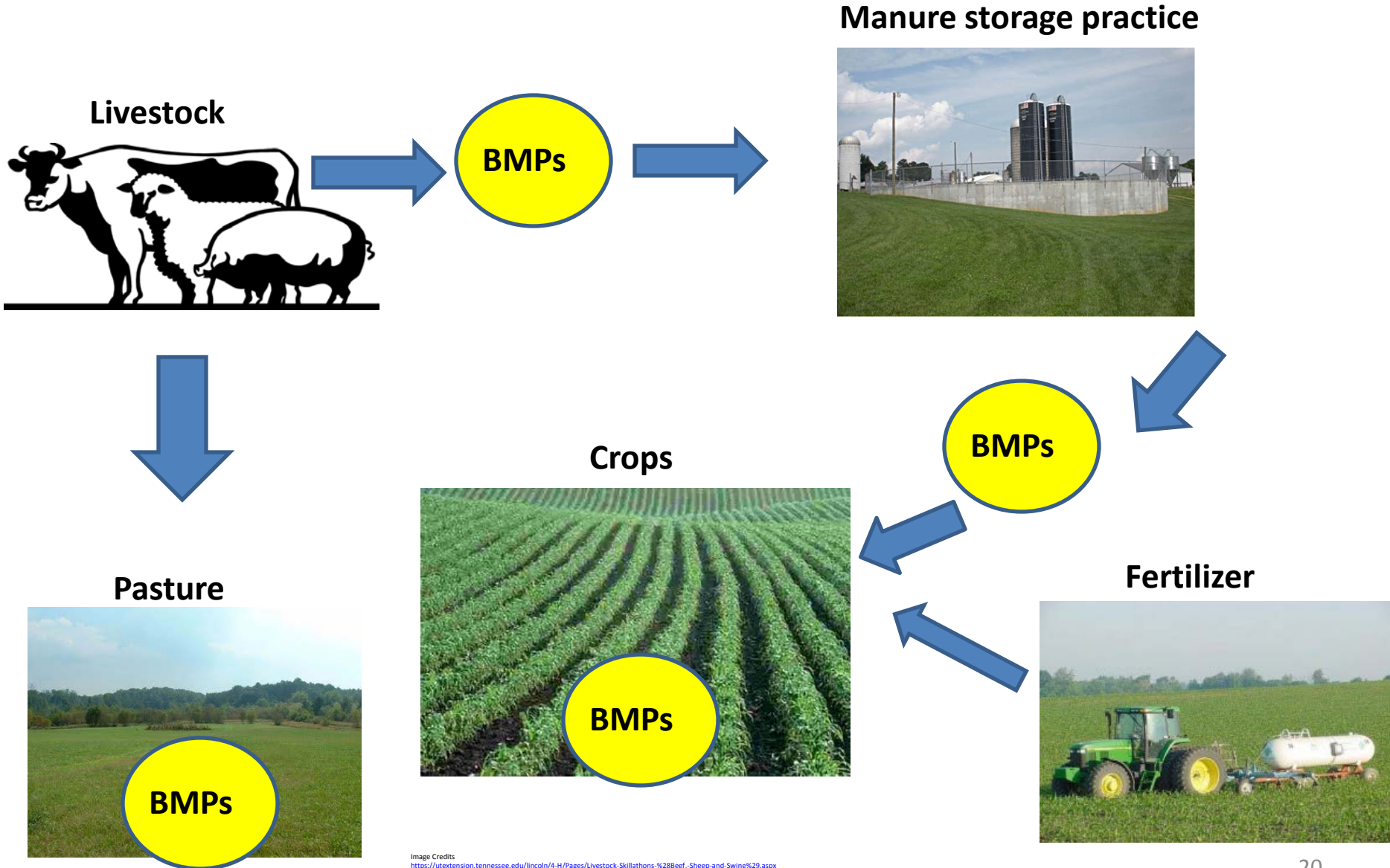
### CBP Watershed Model Phase 5.3.2 Nitrogen Million lb per year (not official progress runs)



# Nutrient Impacts on Bay WQ



# Scenario Builder



# Parameters

(Changeable by user)

- BMP Type and location (NEIEN/State supplied)
- Land acres
- Remote Sensing, NASS Crop land Data layer
- Crop acres
- Yield
- Animal Numbers (Ag Census or state supplied)
- Land applied biosolids
- Septic system (#s)

## Inputs

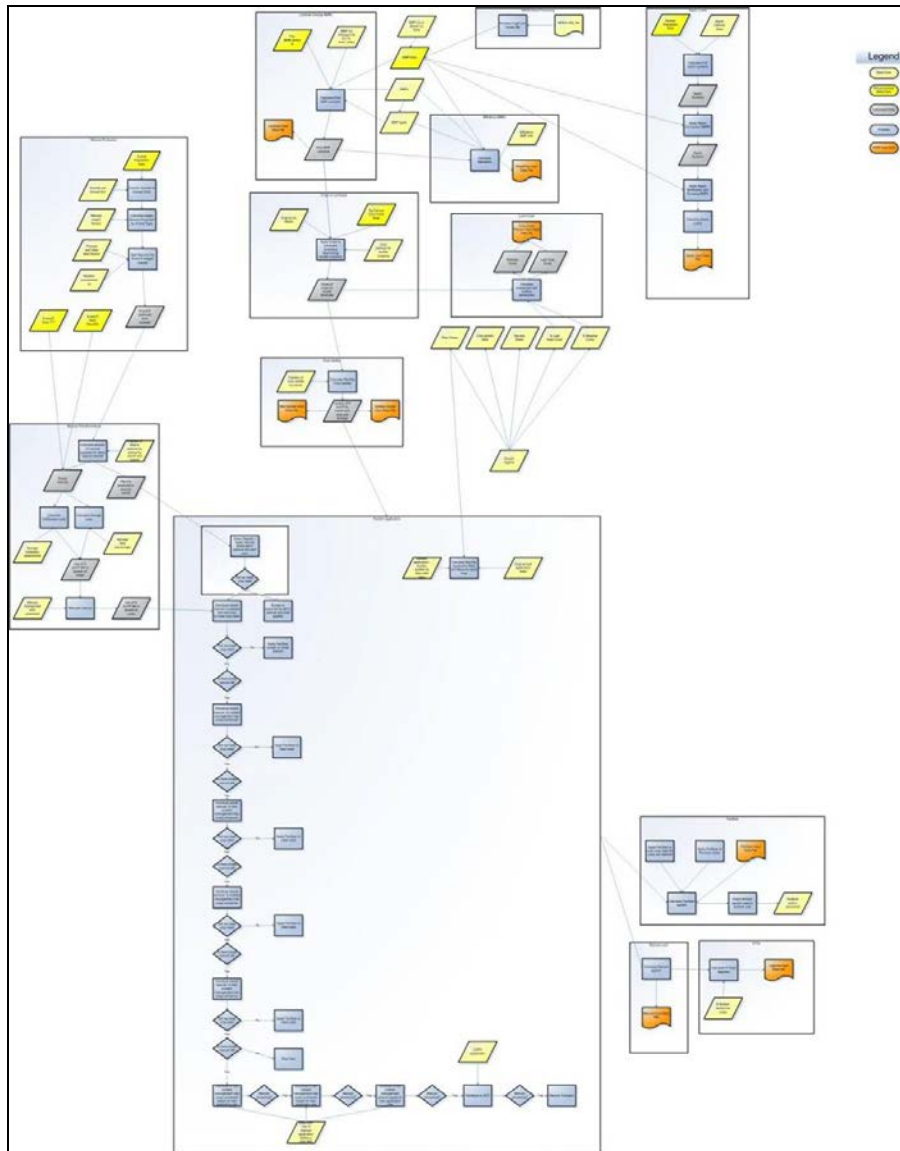
- BMP types and efficiencies
- Land use change (BMPs, others)
- RUSLE2 Data: % Leaf area and residue cover
- Plant and Harvest dates
- Best potential yield
- Animal factors (weight, phytase feed, manure amount and composition)
- Crop application rates and timing
- Plant nutrient uptake
- Time in pasture
- Storage loss
- Volatilization
- Animal manure to crops
- N fixation
- Septic delivery factors

- BMPs, # and location
- Land use
- % Bare soil, available to erode
- Nutrient uptake
- Manure and chemical fertilizer (lb/segment)
- N fixation (lb/segment)
- Septic loads

## Outputs



# Scenario Builder



- Input processor for the Watershed Model
- Generates past, present or future state of watershed conditions
- Specific WSM Inputs from Scenario Builder:
  - Management practices
  - Land use acres
  - Manure and chemical fertilizer application rates
  - Crop growth
  - Septic loads














# Spatial Scale

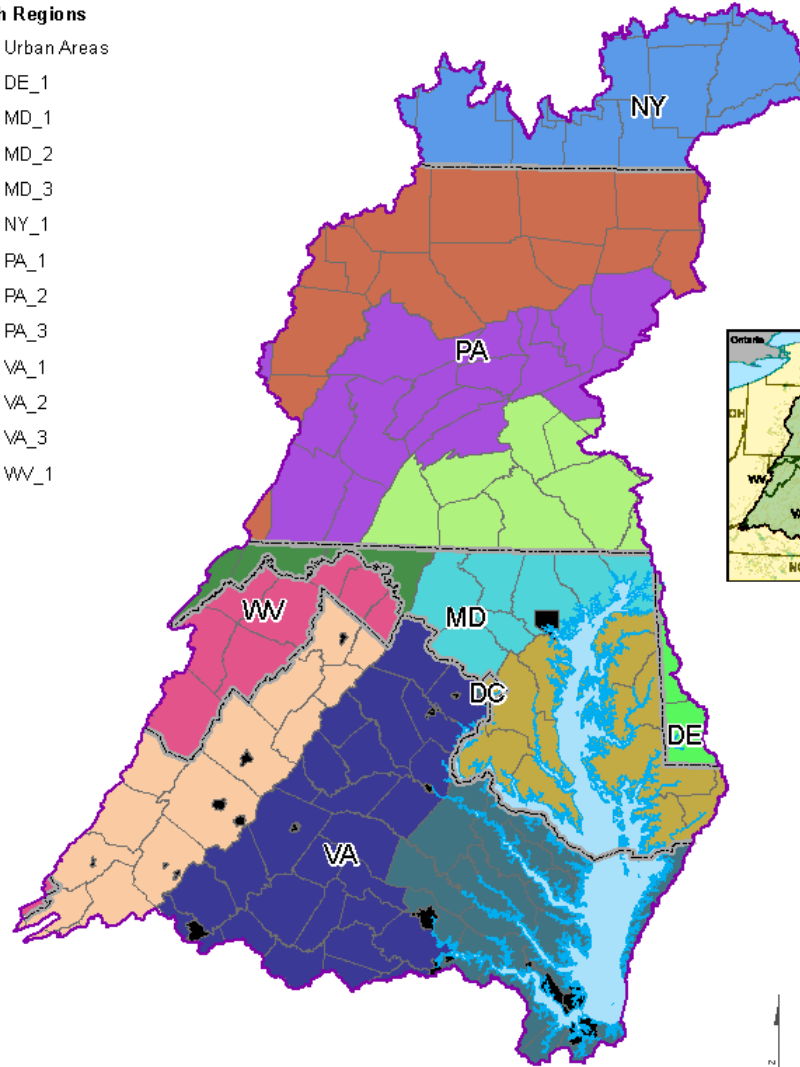
## Scenario Builder Growth Regions

Chesapeake Bay Watershed



### Growth Regions

-  Urban Areas
-  DE\_1
-  MD\_1
-  MD\_2
-  MD\_3
-  NY\_1
-  PA\_1
-  PA\_2
-  PA\_3
-  VA\_1
-  VA\_2
-  VA\_3
-  WW\_1



For more information, visit [www.chesapeakebay.net](http://www.chesapeakebay.net)  
Disclaimer: [www.chesapeakebay.net/termsandconditions](http://www.chesapeakebay.net/termsandconditions)



County scale  
source data and  
calculations.

To output at a finer  
scale, Scenario  
Builder uses an  
area-weighted  
average.

# Scenario Builder Ag Data Output

- BMPs
  - Acres
  - Pounds nitrogen, phosphorus and sediment reduced
- Manure application (nutrient species/month)
- Fertilizer application (month)
- Legumes (pounds ammonium)
- Maximum Crop uptake (monthly nutrients)
- Vegetative cover
- Sediment generated by plowing
- Land use acreage



# Scenario Builder

## Breakout 1

Ag Census Crops

Land Change Model

Land Use

Conservation Practices

## Breakout 2

Ag Census Crops

Regional Crop data

Crop  
Need

BMPs

Vegetative cover

Max uptake

Plowing Effects

## Breakout 3

Ag Census Animals

Regional management data

Leguminous Fixation

Manure application

Fertilizer application

**WATERSHED  
MODEL**

