# Scientific and Technical Advisory Committee

September 14, 2011

# Nutrient Transport in Maryland Coastal Plain Watersheds: What We Know and What Next

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# Discussions Regarding How P Reductions from Agriculture on the Eastern Shore of Maryland were Projected in the CBP Watershed Model for 1985-2000

MD DNR
February 16, 2011

Follow-up June 2011

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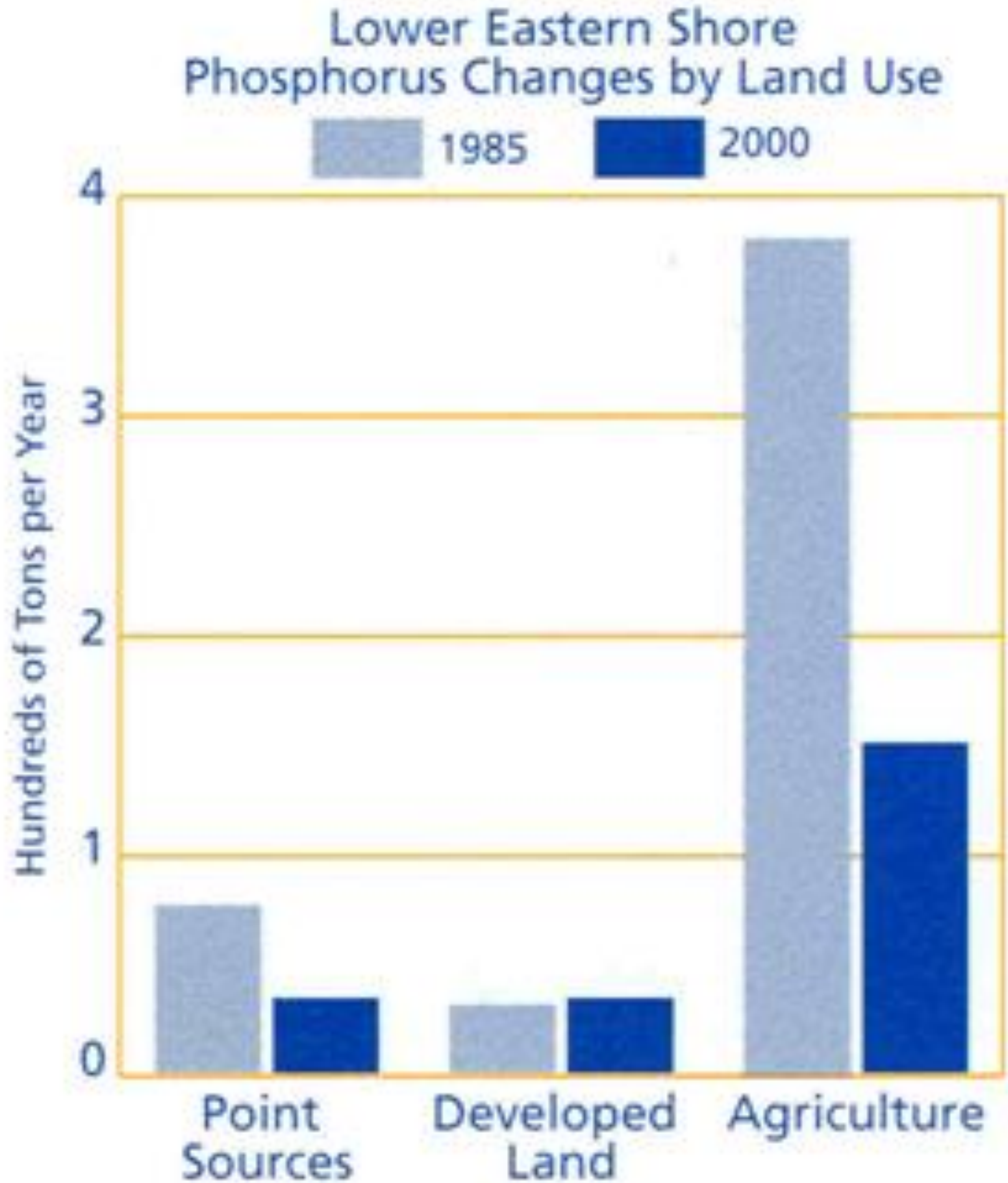
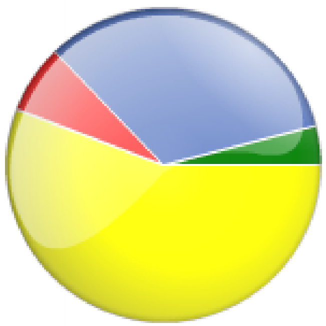

Lower Eastern Shore
Phosphorus Changes by Land Use
1985
2000
Hundreds of Tons per Year
4
3
2
1
0
Point Sources
Developed Land
Agriculture

# Causes of the Problems

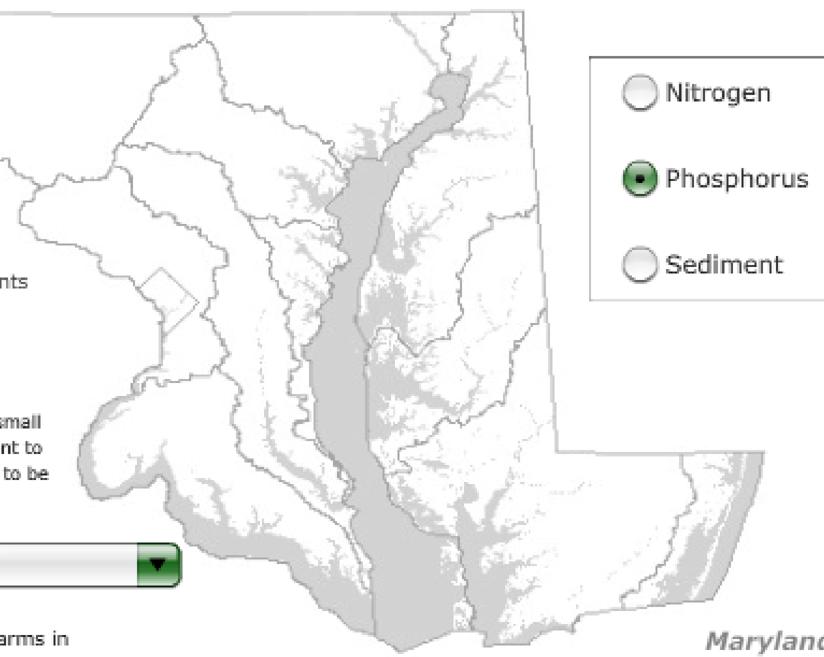
## Lower Eastern Shore

Causes of Phosphorus Pollution



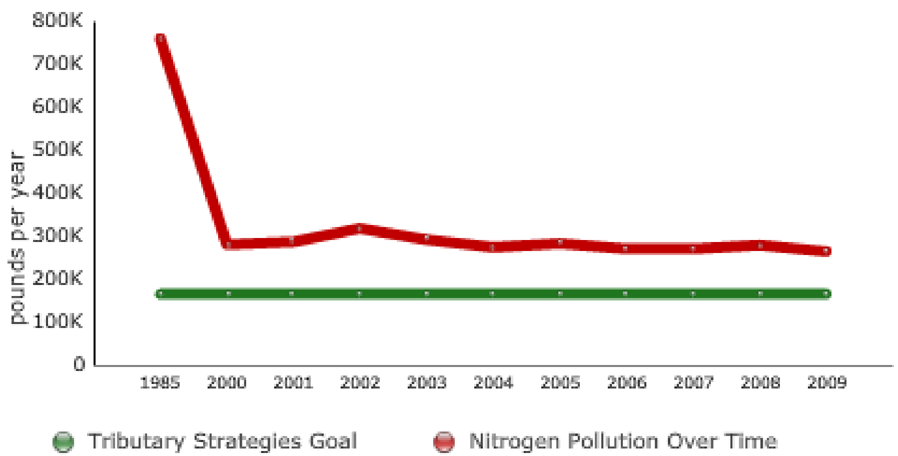

*Forests naturally contribute a small amount of nutrients and sediment to the Bay, but are not considered to be a pollution source.

Farms




- Nitrogen
- Phosphorus
- Sediment

The chart below shows how Phosphorus pollution from Farms in Lower Eastern Shore has changed over time.

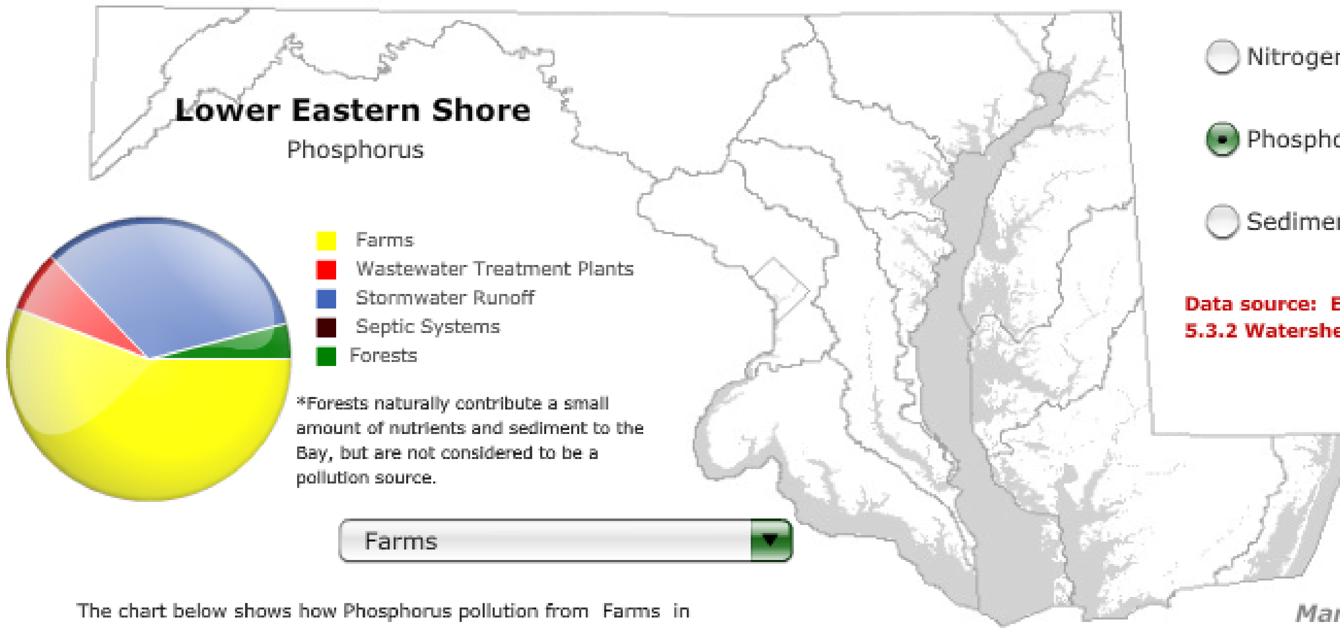



Phosphorus pollution fuels the growth of algae, creating dense, harmful algae blooms that rob the Chesapeake Bay's aquatic life of needed sunlight and oxygen. Phosphorus often attaches to soil and sediment particles on land, entering the Bay many years later when stream banks erode or rainwater washes it into streams, rivers and the Bay. Sources of phosphorus pollution include fertilizers from farmlands, lawns and golf courses; eroding soil & sediment from stream banks in urban and suburban neighborhoods; animal manure from farms; and wastewater from industrial facilities and sewage treatment plants.

The MD Baystat website shows large P reductions in all three Eastern Shore tribs for 1985-2000, especially the lower Eastern Shore. The narrative for what actions generated these reductions is largely absent.

# Look forward, not backwards!

# Causes of the Problems



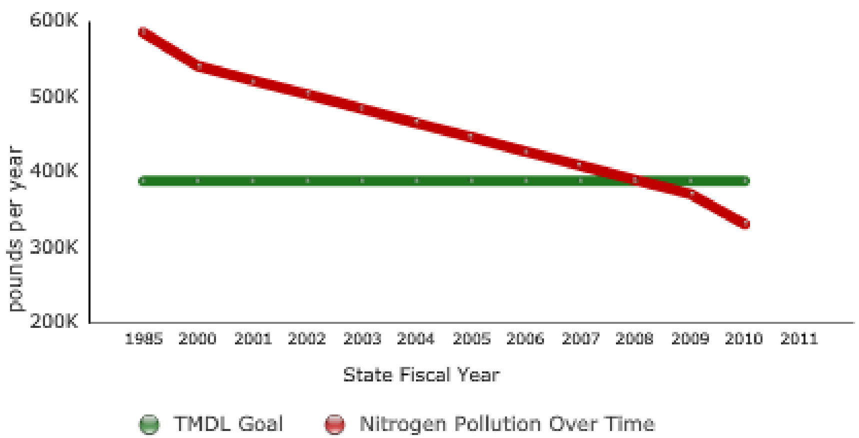

Nitrogen

Phosphorus

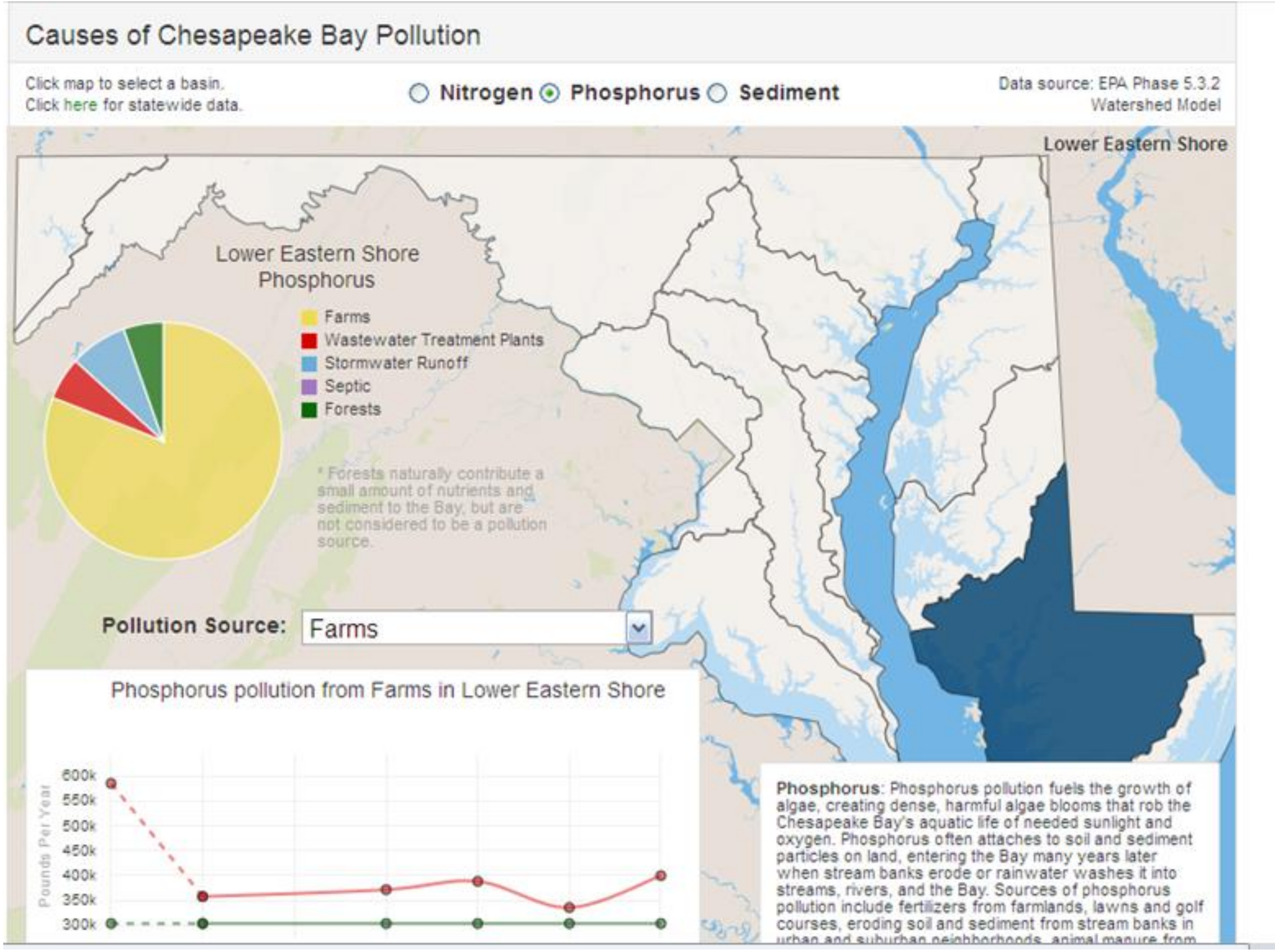
Sediment

**Data source: EPA Phase 5.3.2 Watershed Model.**

The chart below shows how Phosphorus pollution from Farms in the Lower Eastern Shore has changed over time.




Phosphorus: Phosphorus pollution fuels the growth of algae, creating dense, harmful algae blooms that rob the Chesapeake Bay's aquatic life of needed sunlight and oxygen. Phosphorus often attaches to soil and sediment particles on land, entering the Bay many years later when stream banks erode or rainwater washes it into streams, rivers and the Bay. Sources of phosphorus pollution include fertilizers from farmlands, lawns and golf courses; eroding soil & sediment from stream banks in urban and suburban neighborhoods; animal manure from farms; and wastewater from industrial facilities and sewage treatment plants.



Causes of Chesapeake Bay Pollution
Click map to select a basin.
Click here for statewide data.
Nitrogen
Phosphorus
Sediment
Data source: EPA Phase 5.3.2 Watershed Model
Lower Eastern Shore
Lower Eastern Shore Phosphorus
Farms
Wastewater Treatment Plants
Stormwater Runoff
Septic
Forests
* Forests naturally contribute a small amount of nutrients and sediment to the Bay, but are not considered to be a pollution source.
Pollution Source:
Farms
Phosphorus pollution from Farms in Lower Eastern Shore
Pounds Per Year
600k
550k
500k
450k
400k
350k
300k
Phosphorus: Phosphorus pollution fuels the growth of algae, creating dense, harmful algae blooms that rob the Chesapeake Bay's aquatic life of needed sunlight and oxygen. Phosphorus often attaches to soil and sediment particles on land, entering the Bay many years later when stream banks erode or rainwater washes it into streams, rivers, and the Bay. Sources of phosphorus pollution include fertilizers from farmlands, lawns and golf courses, eroding soil and sediment from stream banks in

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September 17, 2013

## Findings of the STAC ad hoc workgroup on how P transport from cropland is simulated in the Bay watershed model

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# The workgroup

- Scott Ator -- USGS
- Anthony Buda – USDA ARS (PA)
- Quirine Ketterings -- Cornell
- Peter Kleinman – USDA ARS (PA)
- Tom Sims – UD
- Gary Shenk – EPA
- Russ Brinsfield – STAC (UMD)
- Bob Hirsch – STAC (USGS)
- Jack Meisinger – STAC (USDA ARS)

# Objective 1

To gain an in-depth understanding of how the CBP watershed model currently simulates phosphorus loads from cropland and whether the current simulation approach is consistent with the latest scientific consensus regarding phosphorus transport mechanisms.

# Objective 2

To make recommendations regarding how the CBP modeling approach should b restructured to more accurately reflect the latest research findings regarding phosphorus transport processes and what data inputs will be needed to support calibration and verification of a restructured modeling approach.

# Activities

- February 6, 2012 – full day meeting with Gary Shenk to understand the current modeling approach
- February 29, 2012 – follow-up questions submitted to the Bay Program watershed modeling group
- December 2, 2012 – Received first installment of answers
- February 5, 2013 – Received full set of answers

# Lots of Convergence

- STAC Lag time conference
- Bay Program Ag workgroup expert panels (tillage, nutrient management, manure management, cover crops, riparian buffers)
- STAC trends workshop
- Building a Better Bay model conference

# Five basic things the model does

1. Calculates P loading rates to cropland based on a set of assumptions regarding animal numbers, P excretion rates and inorganic fertilizer use. Temporal and spatial distribution based on second set of assumptions.
2. Assumptions regarding P sorption/desorption used to partition applied P in soil pools.
3. Crops remove P from soil.
4. Simulated hydrology moves water through the soil profile interacting with soil P pools to drive edge-of-field losses.
5. Adjusts edge-of-field loads to account for gains and losses before delivered to the Bay.

# An important point

Changes in simulated P losses in different model versions due primarily to changes in input data sets rather than changes in transport algorithms.

# Asked for information for three Bay watershed areas

1. PA dairy –
   Bradford county
2. Lower Susquehanna mixed –
   Lancaster county
3. Delmarva poultry –
   Somerset county


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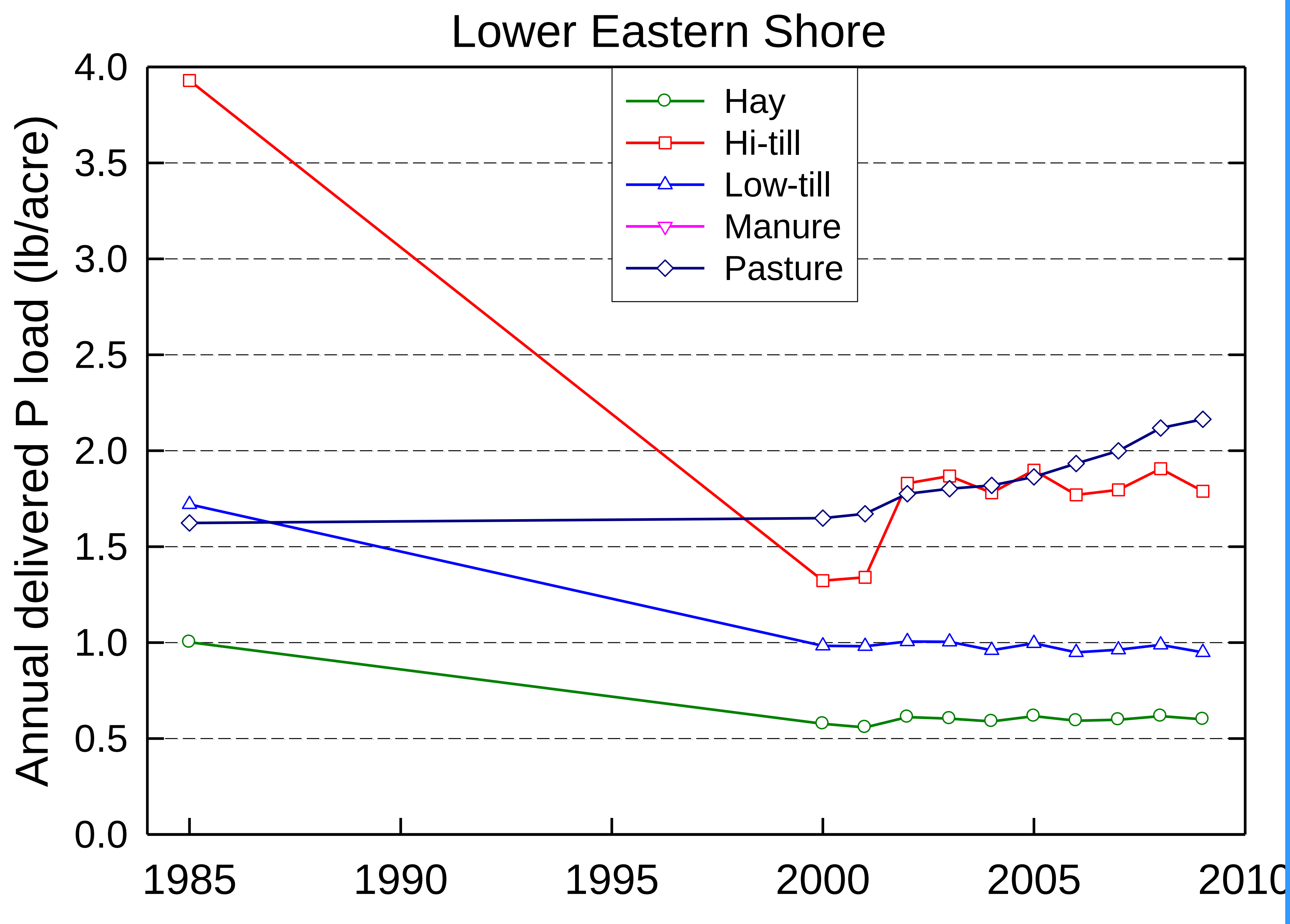
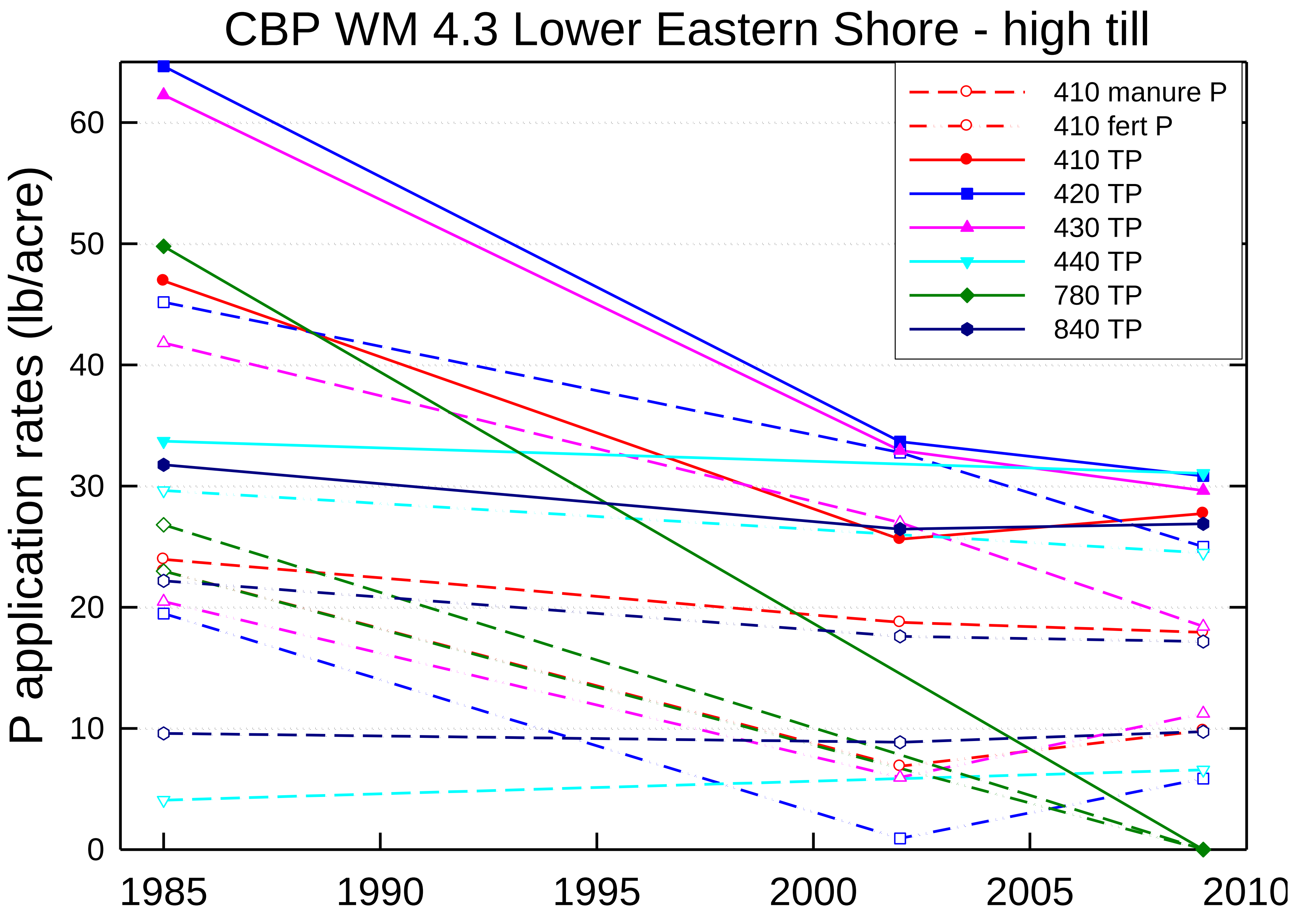
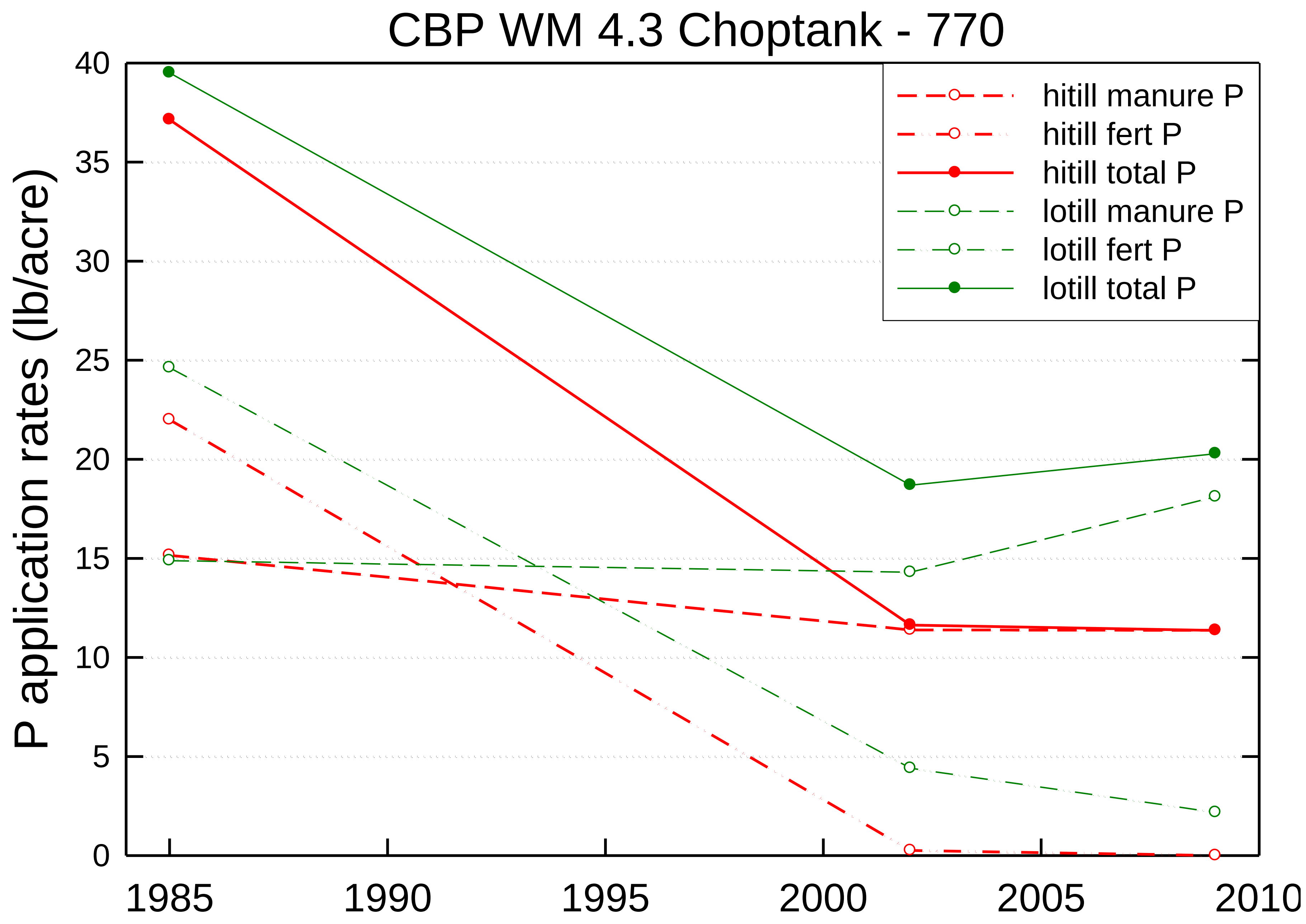

Lower Eastern Shore
Annual delivered P load (lb/acre)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1985
1990
1995
2000
2005
2010
Hay
Hi-till
Low-till
Manure
Pasture


CBP WM 4.3 Lower Eastern Shore - high till
P application rates (lb/acre)
0
10
20
30
40
50
60
1985
1990
1995
2000
2005
2010
410 manure P
410 fert P
410 TP
420 TP
430 TP
440 TP
780 TP
840 TP


CBP WM 4.3 Choptank - 770
P application rates (lb/acre)
0
5
10
15
20
25
30
35
40
1985
1990
1995
2000
2005
2010
hitill manure P
hitill fert P
hitill total P
lotill manure P
lotill fert P
lotill total P

# Some version 4.3 conclusions

1. 4.3 P application rates were cut dramatically from 1985 to 2000 in both LES and Choptank 770 segments. Choptank fert P nearly eliminated.
2. Total P application reductions are similar on a percentage basis with projected delivered load reductions (40-60%).
3. Greater P application reductions on hitil versus lotil acres.
4. 2000 LES P application rates still greater than crop removal, indicates soil P still increasing.
5. LES manure P seems to disappear from 85-2000.
6. 1985 4.3 manure P numbers close to MAWP numbers.

# Inferences from version 4.3

Large 4.3 projected reductions in LES delivered P loads were driven primarily by large reductions in P application rates from 1985-2000. Basis for such large reductions in P application rates seems unclear. Mechanistically, the model seems overly sensitive to P application rates, neglecting effect of soil P reservoirs.

# Peter Kleinman (Feb 6 meeting)

"Desorption is the largest contributor of P in edge of field studies, not application of P."

# An apparent model weakness

If manure distributed in a segment is less than crop needs, the model applies inorganic P fertilizer at the rate necessary to meet crop needs. Surplus applications typically associated with organic nutrient sources and the potential for draw down of P reserves are missed.

# Forward – What the model should do.

1. Account for existing soil P reservoir
2. Track segment P balances
3. Vary soil P isotherms based on soil type
4. Apply manure at times and rates based on regional information
5. Account for variation in P application method
6. Account for P stratification in CNT

# Forward – What the model should do.II

7. Consider interaction between tillage and manure applications
8. Account for differences in connectivity that affect delivery efficiency
9. Describe the temporal dynamics of the effects of drawdown of soil P on loads
10. Be capable of scaling down to provide segment by segment guidance on drivers of P losses and needed practices
11. Dissolved P!

# Summary

1. Soil P concentrations and how we manage P applications are the major drivers for P losses that we can control.

2. The simulation process needs to capture the impact of management on key drivers of P transport which will drive collection of essential data.

# Richard Feynman - 1986

"Therefore, things must be learned only to be unlearned again or, more likely, to be corrected… The test of all knowledge is experiment."