

3rd Annual
Midwest Soil Improvement Symposium:
2013

Research and Practical Insights into Using Gypsum

March 7, 2013

***Gypsum Curtains:
Edge-of-field Phosphorus Filtration***

Dr. Ray Bryant

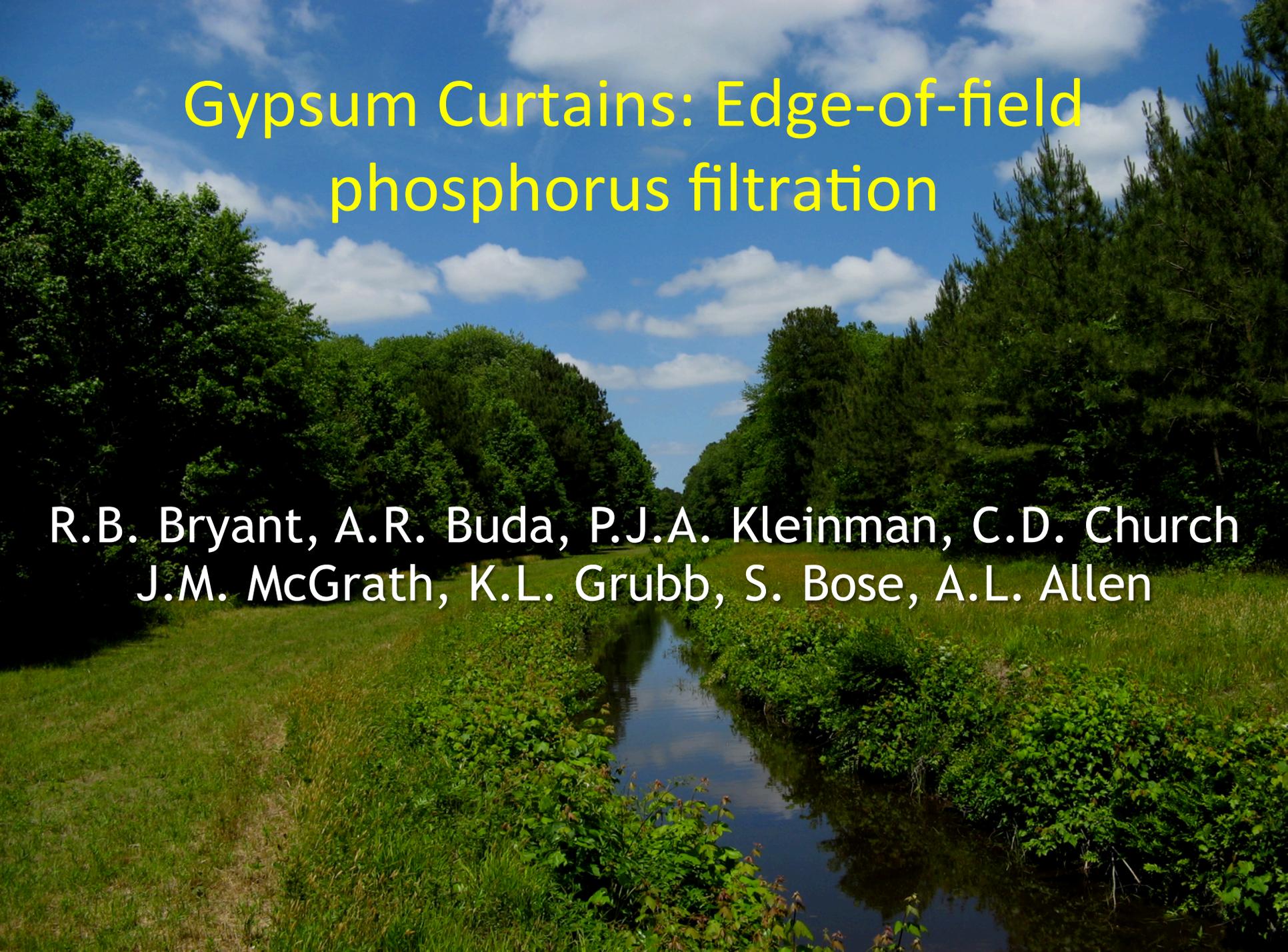
Research Soil Scientist, Pasture Systems and Watershed Mgmt.

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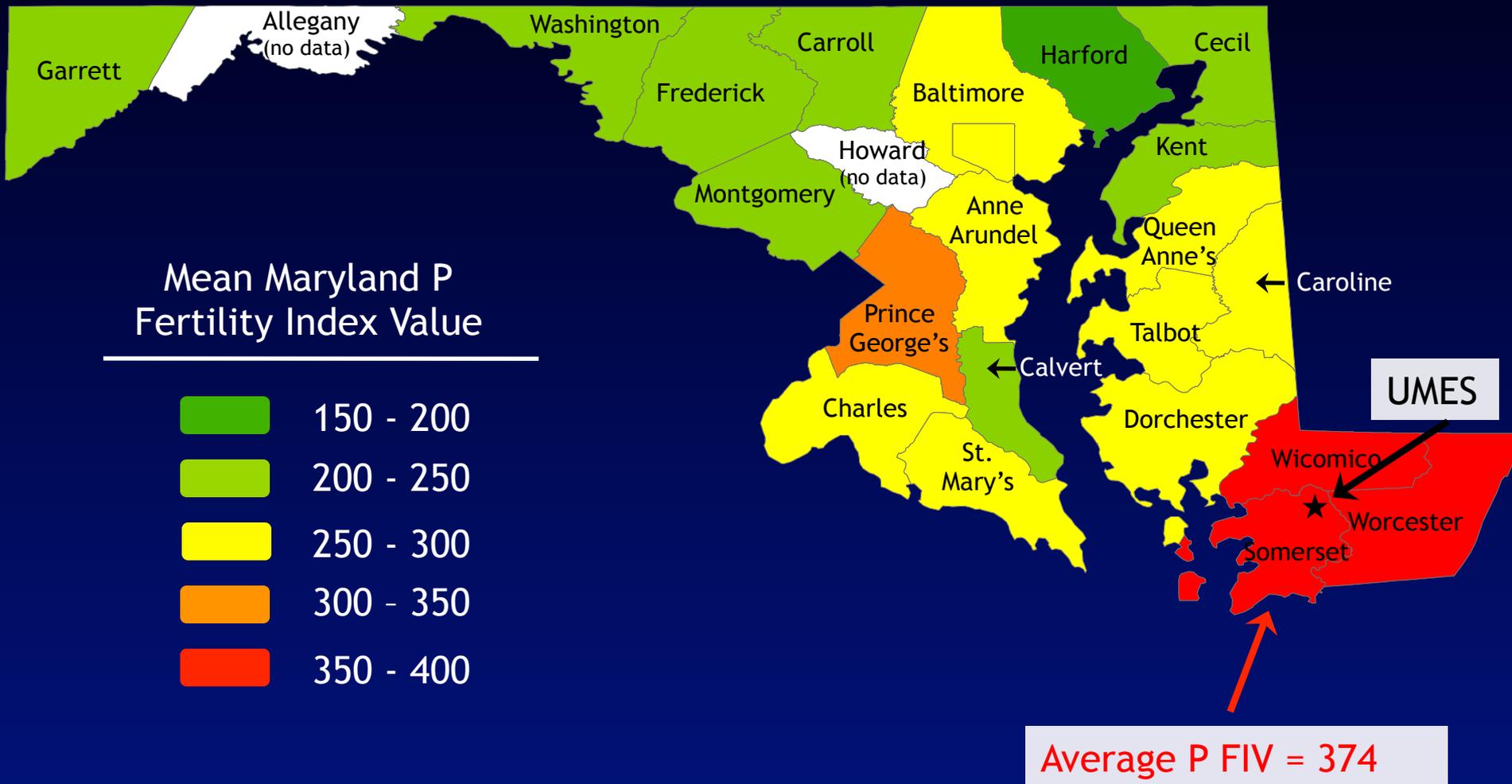
Gypsum Curtains: Edge-of-field phosphorus filtration



R.B. Bryant, A.R. Buda, P.J.A. Kleinman, C.D. Church
J.M. McGrath, K.L. Grubb, S. Bose, A.L. Allen

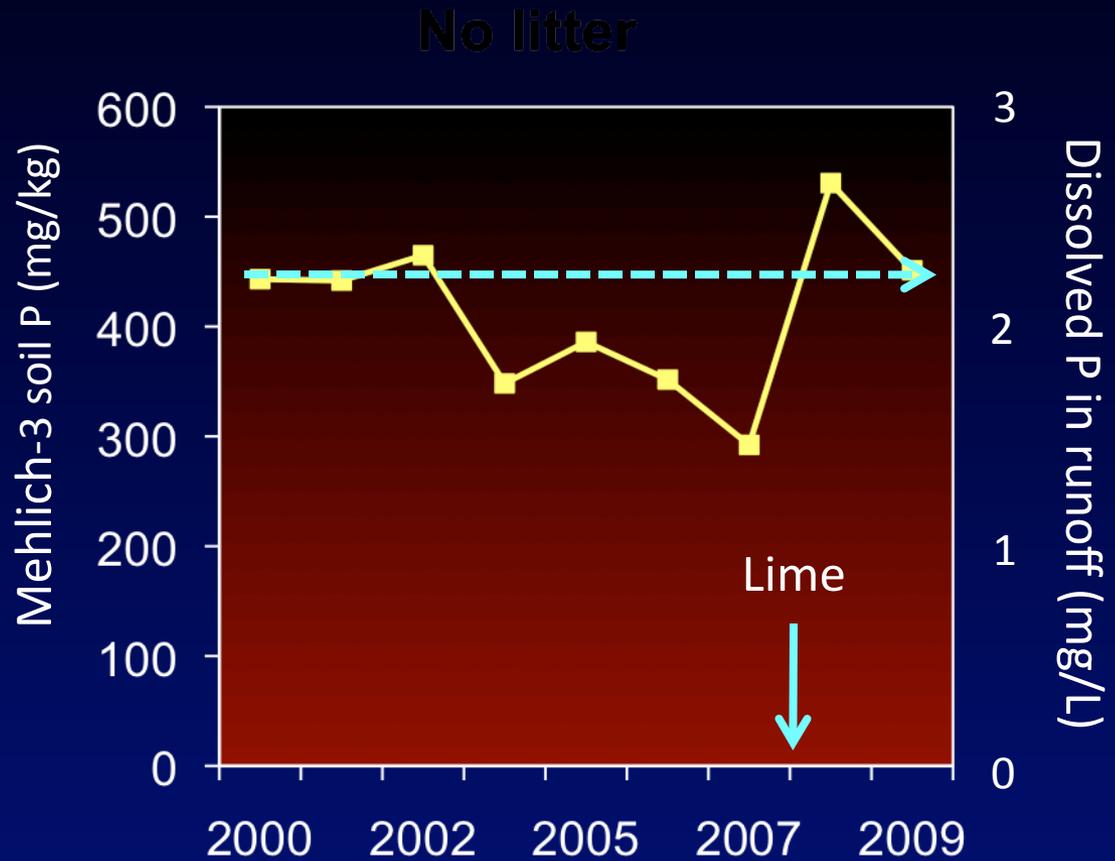
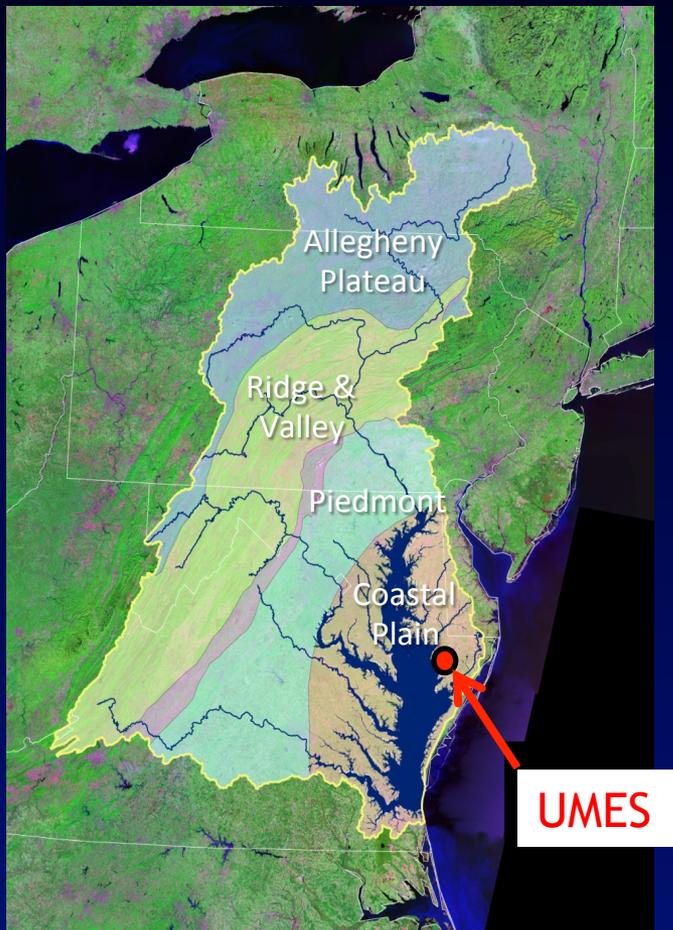
Soil test P levels are high on the Eastern Shore of Maryland

Restricted to fields where the Maryland P Index was run (FIV > 150 only)



No change in soil test P after one decade of continuous corn : Zero P additions

High soil P has water quality consequences

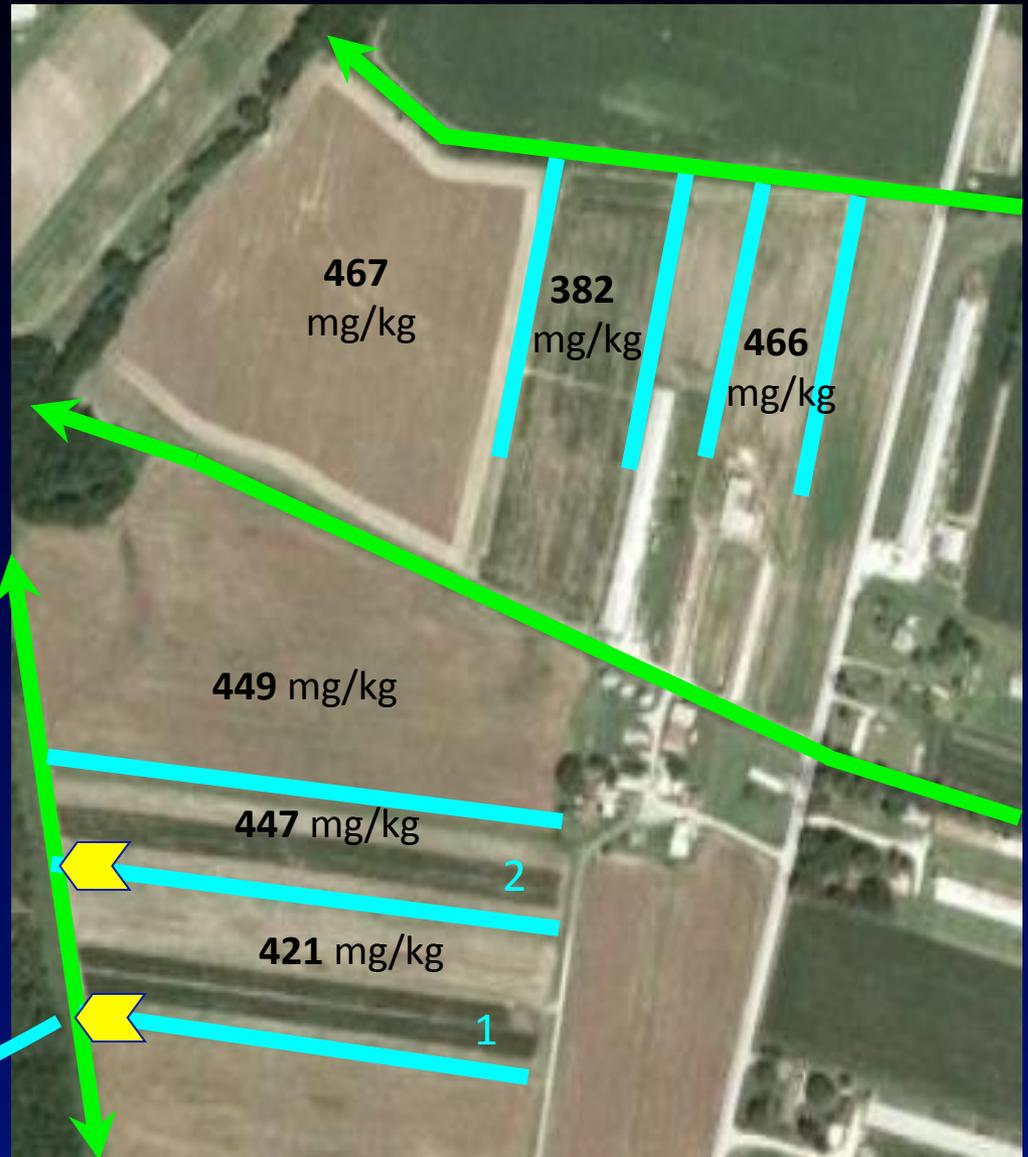
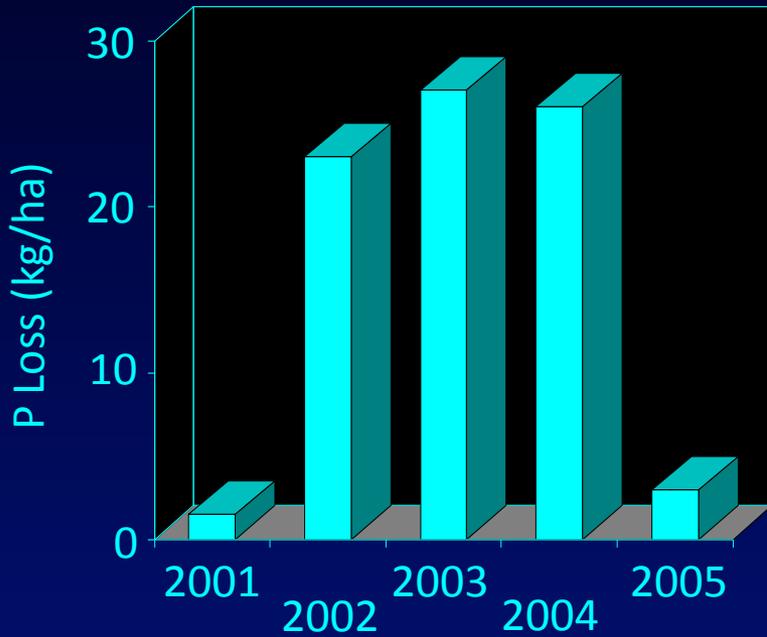


Maryland, USA (Kleinman et al., 2010)

Total P loads from drainage ditches

Annual loads vary with precipitation

UMES Experiment
Station
Former Poultry Farm



BAY JOURNAL

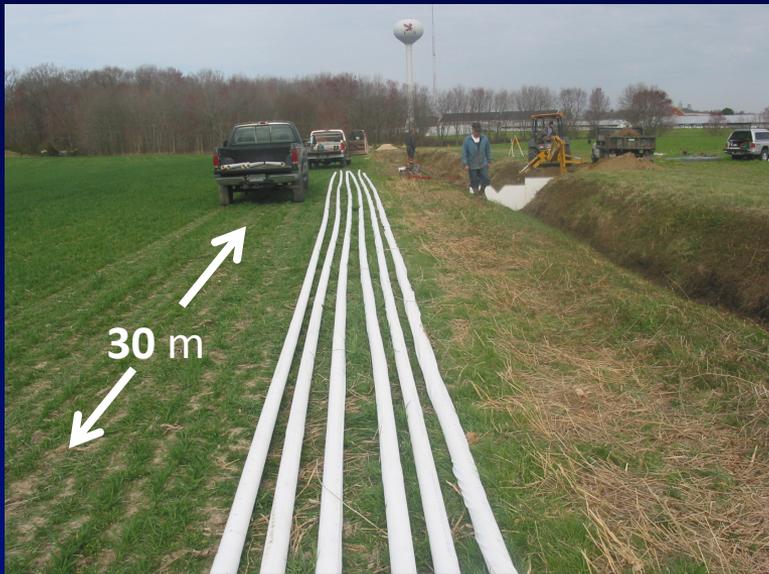
EPA finds flaws in most states' plans to clean up waterways

Initial Findings: Agricultural

- Limited assurance that agricultural reductions will be met, given little to no detail on plan for building technical assistance, leveraging financial incentives and verifying implementation of practices
- Implementation rates of proposed conservation practices are unrealistic to achieve by 2025 unless incorporated into state technical standards or other regulatory programs
- No or limited commitment to improving phosphorus (P) management to address high P in soils and related excess manure
- Additional reductions may be possible through new technologies (e.g., manure incorporation)
- Compliance/enforcement strategies inadequate

FGD gypsum filter - 1st generation

120 tons of FGD gypsum (5 truck loads)



P Removal by filtration



Dissolved P, As, and pH



AsP = 0.1003 mg L⁻¹
pH = 7.8

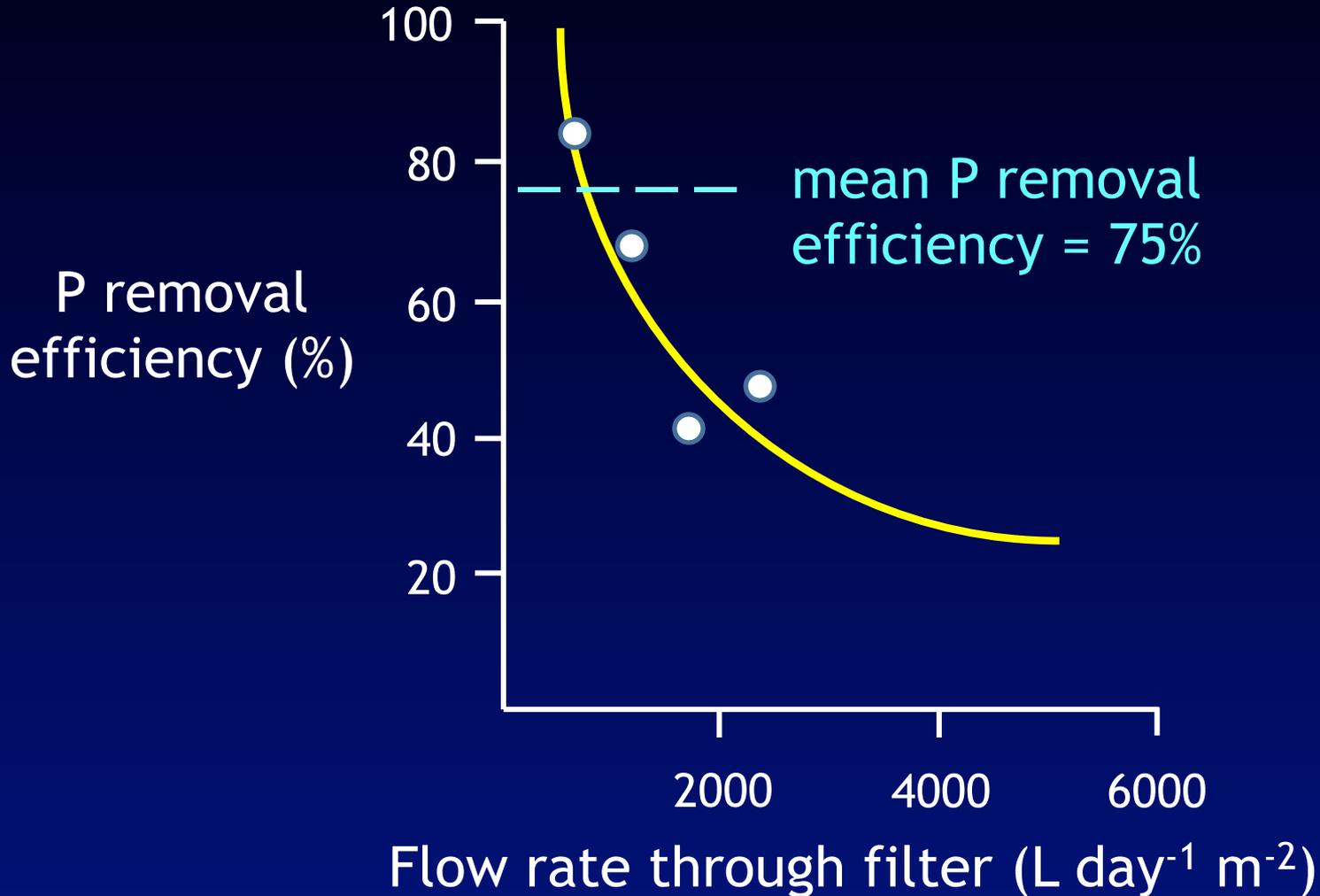
Gypsum

AsP < 0.001 mg L⁻¹
pH = 8.8
(non detect)

Gypsum

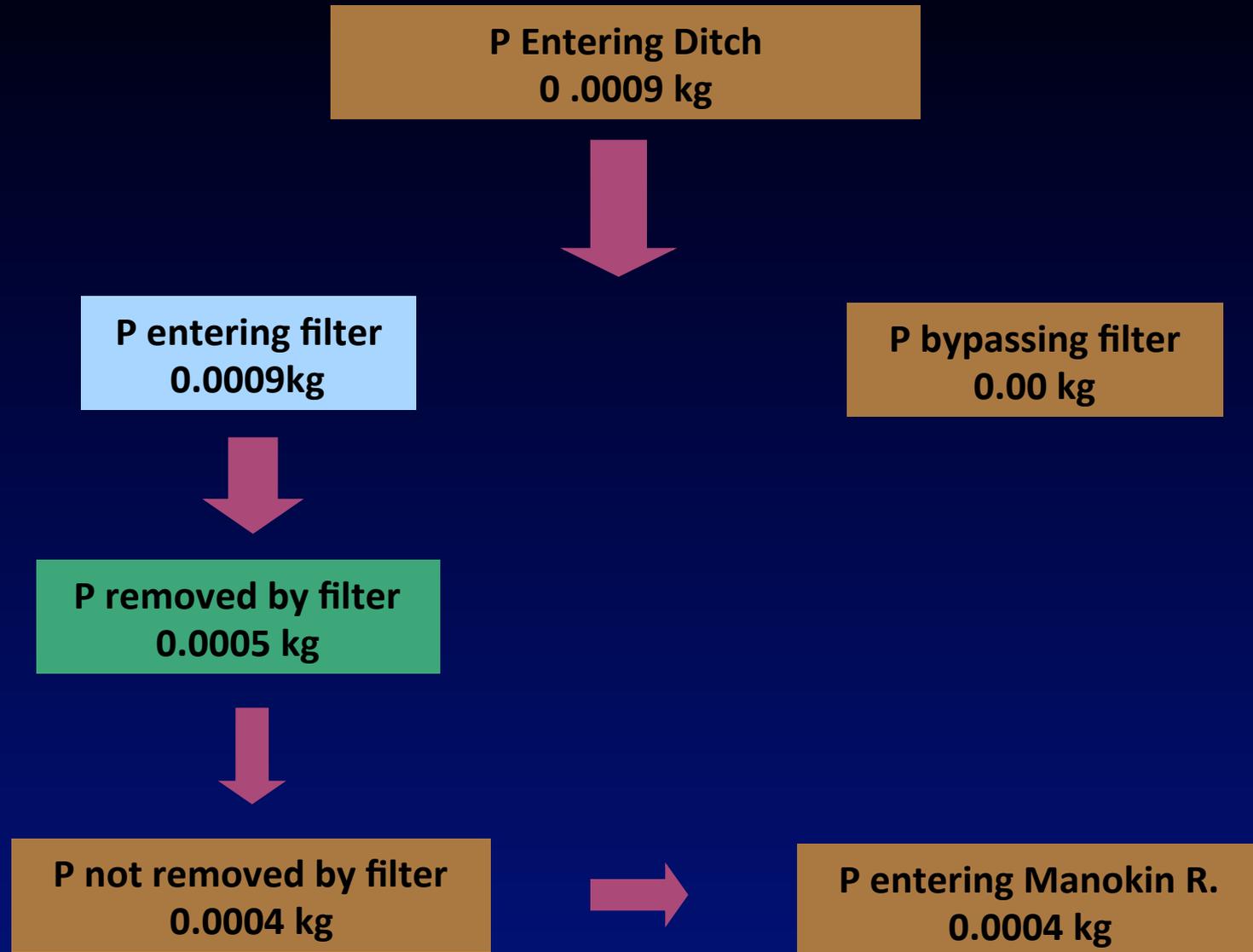


P removal efficiency is greatest at low flow rates



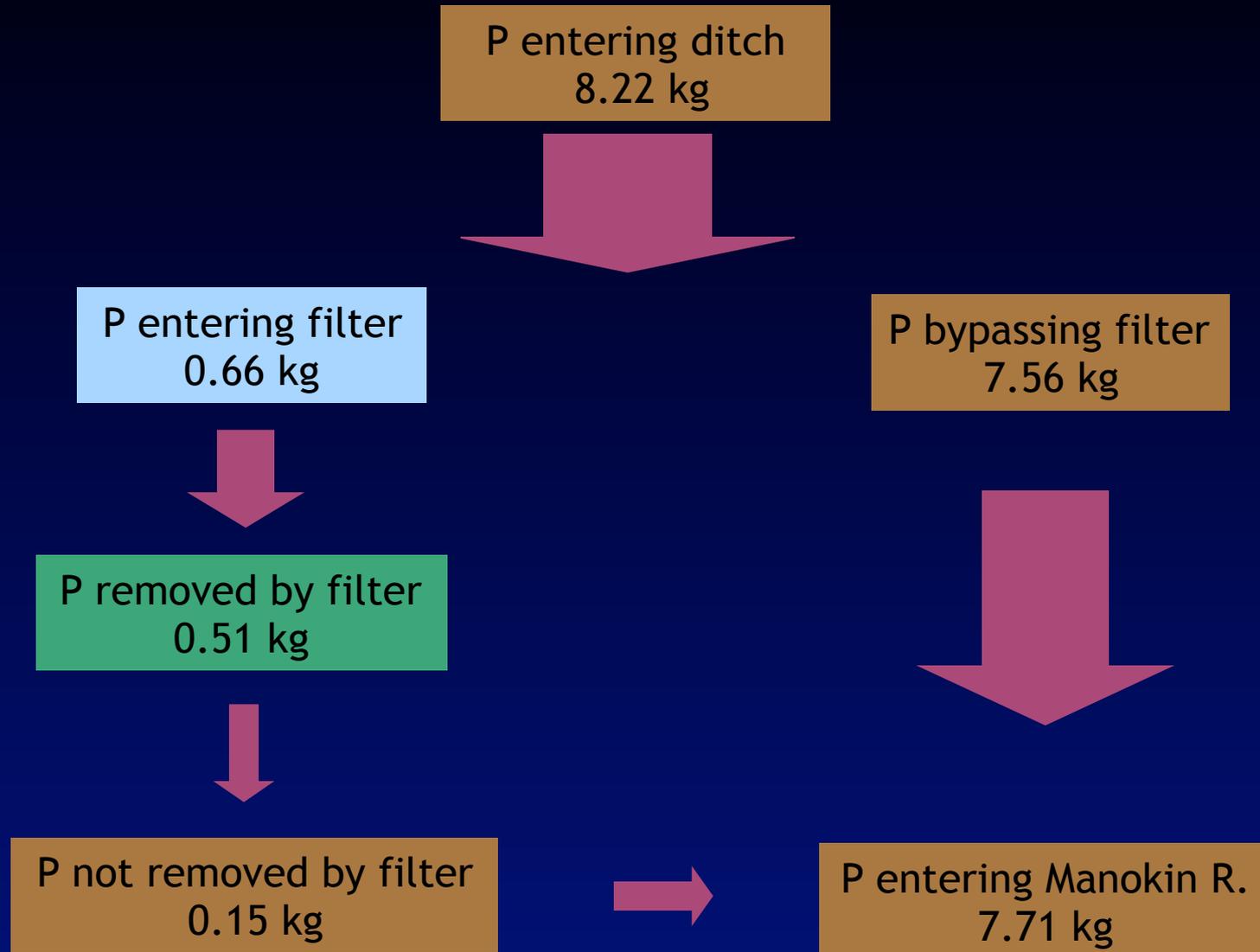
P removal by gypsum filter for April 13, 2007

Storm event: 0.64 inches of rain in 13 hrs.

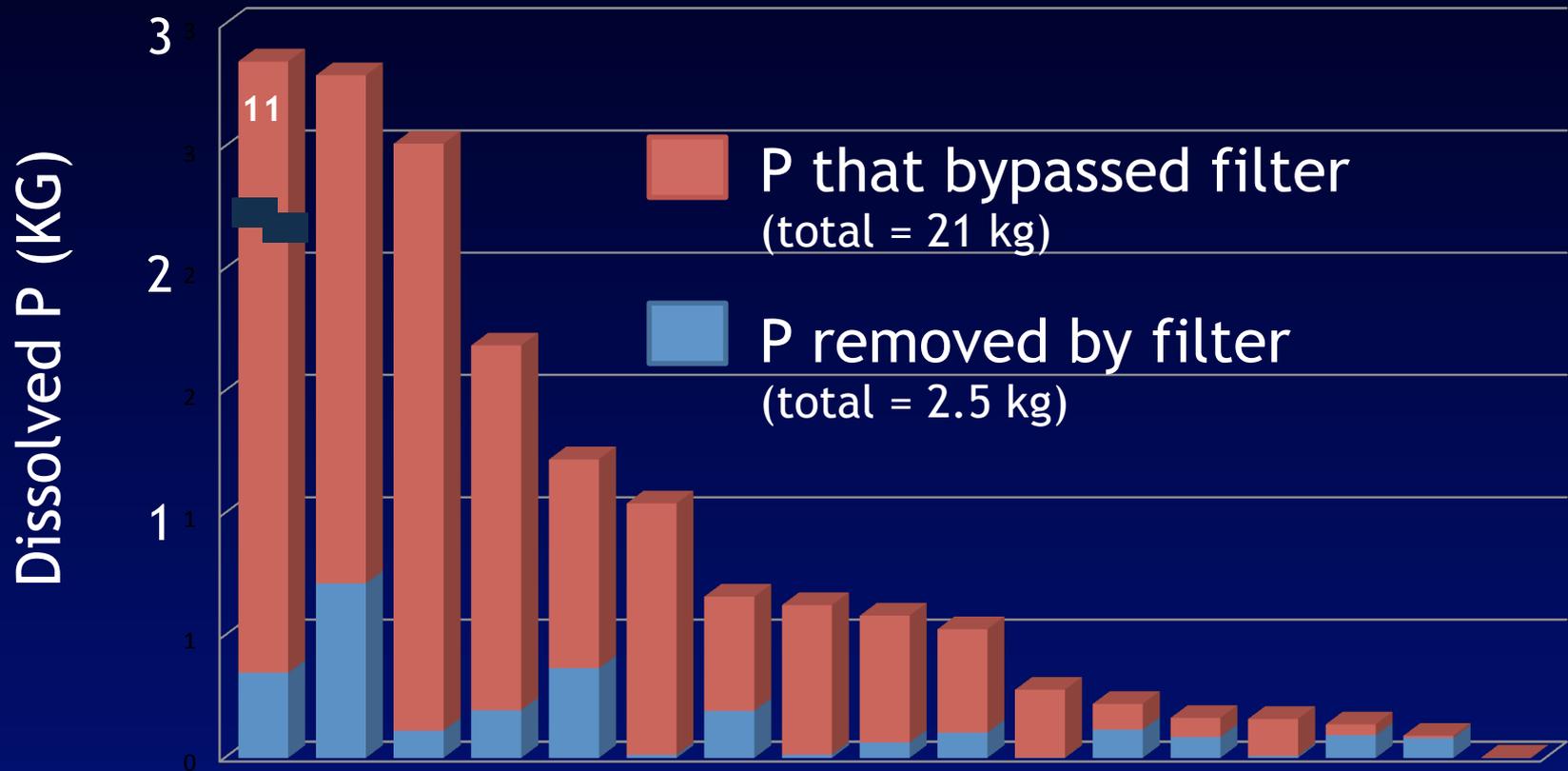


P removal by gypsum filter for April 18, 2007

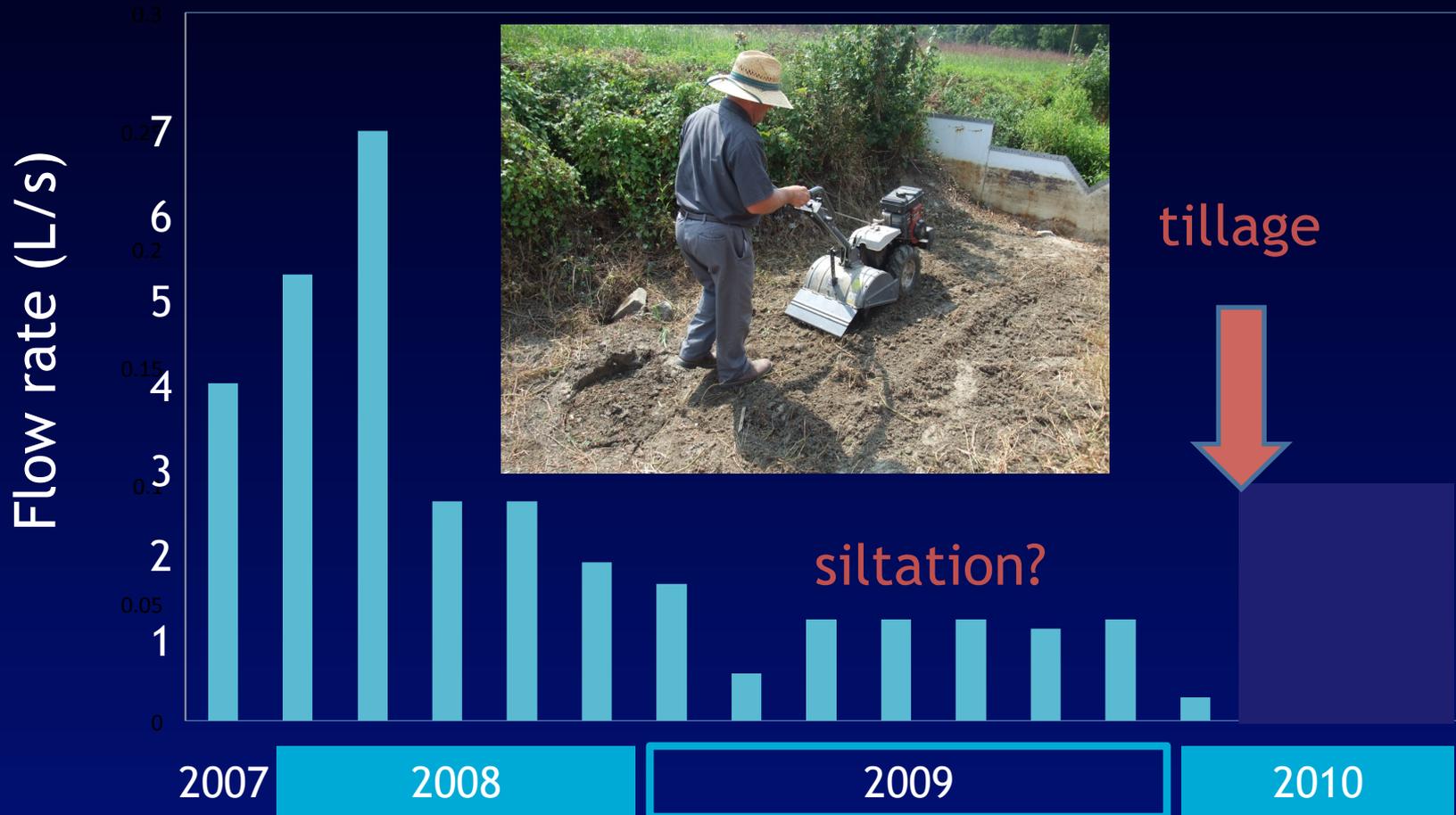
Storm event: 3.31 inches of rain in 30 hrs.



Dissolved P loads in 17 storm events



Maximum flow rate through gypsum over time



Conclusions

- Gypsum was chemically efficient: 70% P removal from water passing through gypsum
- Total efficiency over the 4 year life of the filter was only 22% P removal due to bypass flow
- Hydraulic conductivity decreased from 4 L min⁻¹ to < 1 L min⁻¹ over time
- Maintenance requirements: tillage of the filter surface, dam and spillway inspections and repairs, clean out when gypsum is “spent”

The future of filtration

Josh McGrath is working with gypsum and other materials in new ditch filter designs.
\$1M NRCS Conservation Innovation Grant

Aleksandra Drizo, U of Vermont, is working with steel slag in canister filters designed to address point sources such as barnyards.

Meanwhile, back at UMES...

Acid mine drainage
treatment residuals
(Fe & Al oxides)



Drinking water
treatment residuals
(alum)



Steel slag



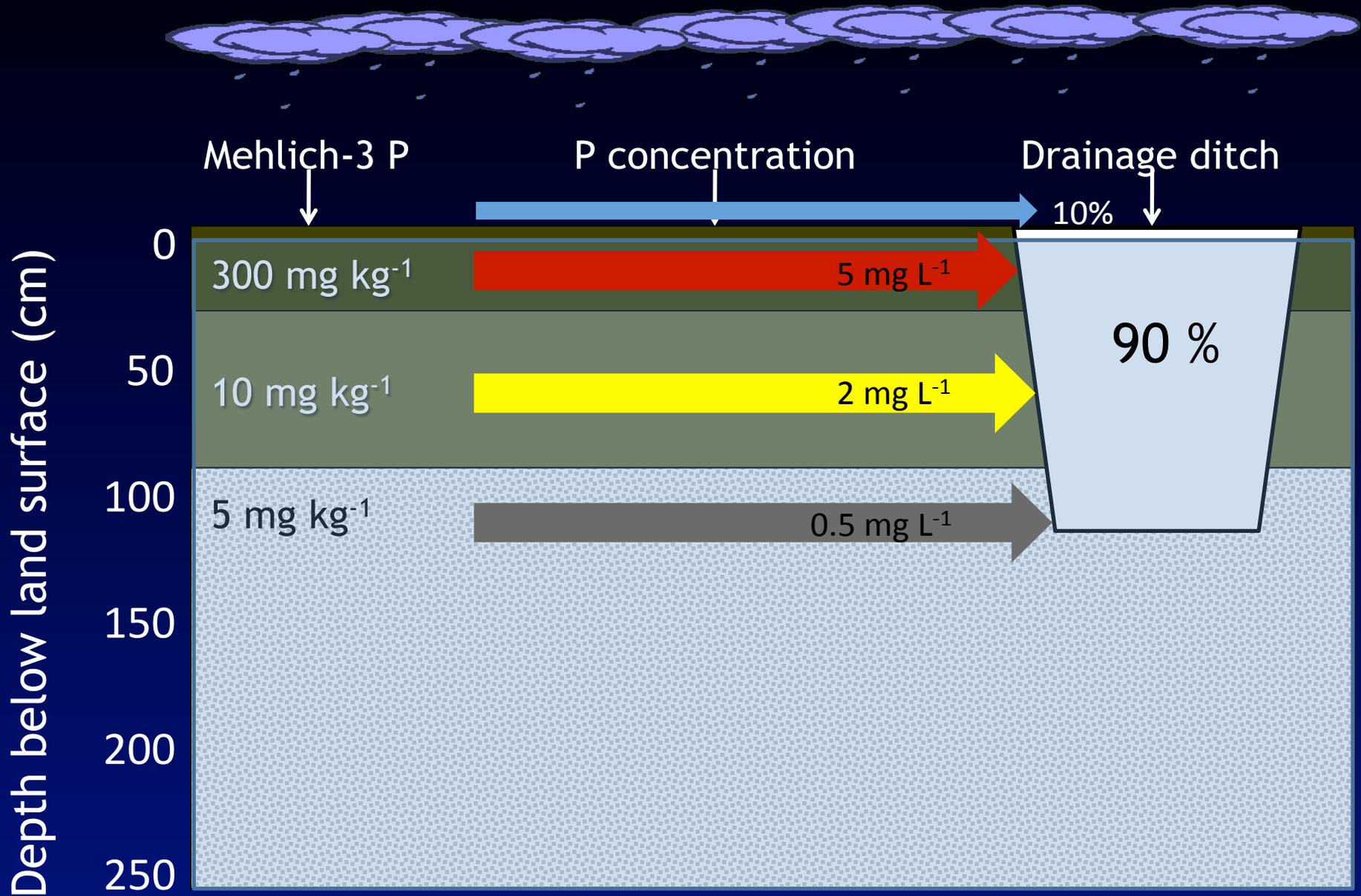
FGD gypsum



Fly ash



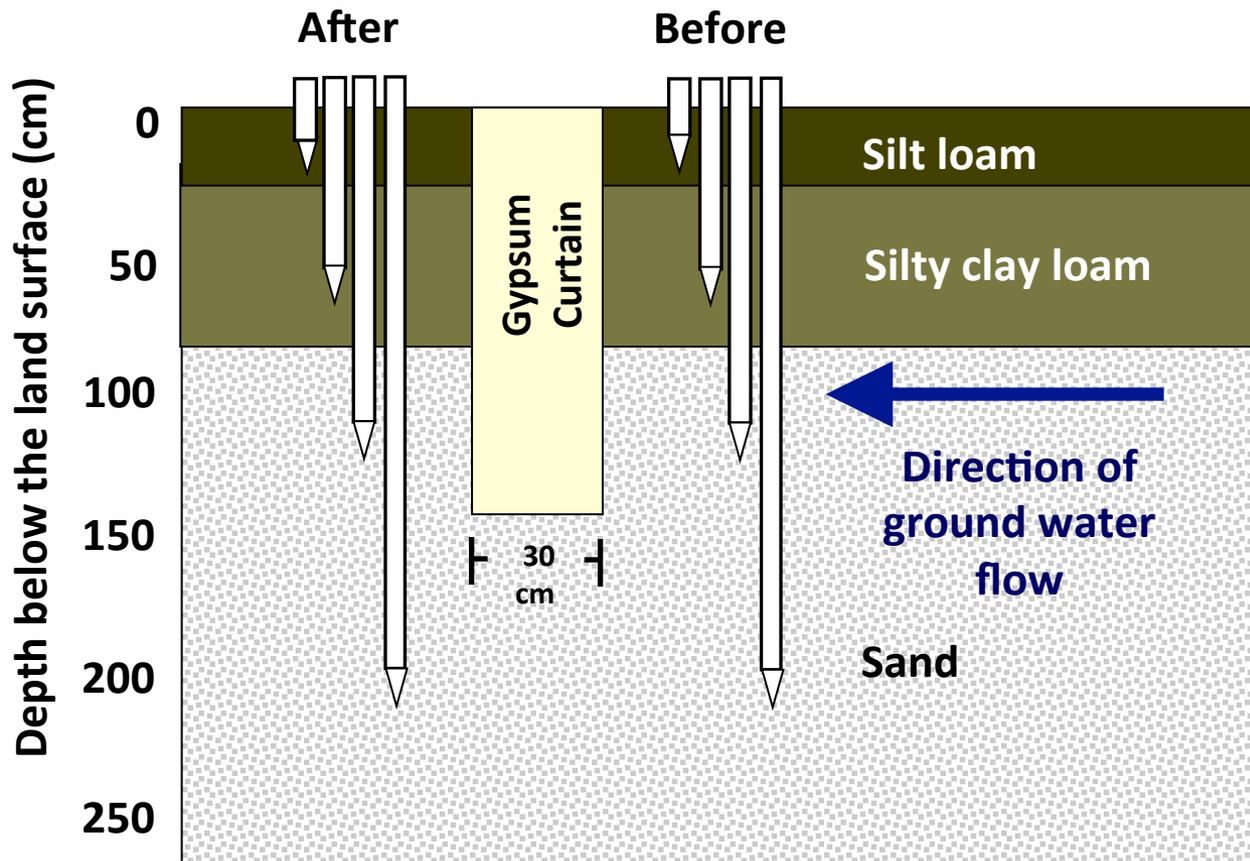
P transport processes in Coastal Plain soils



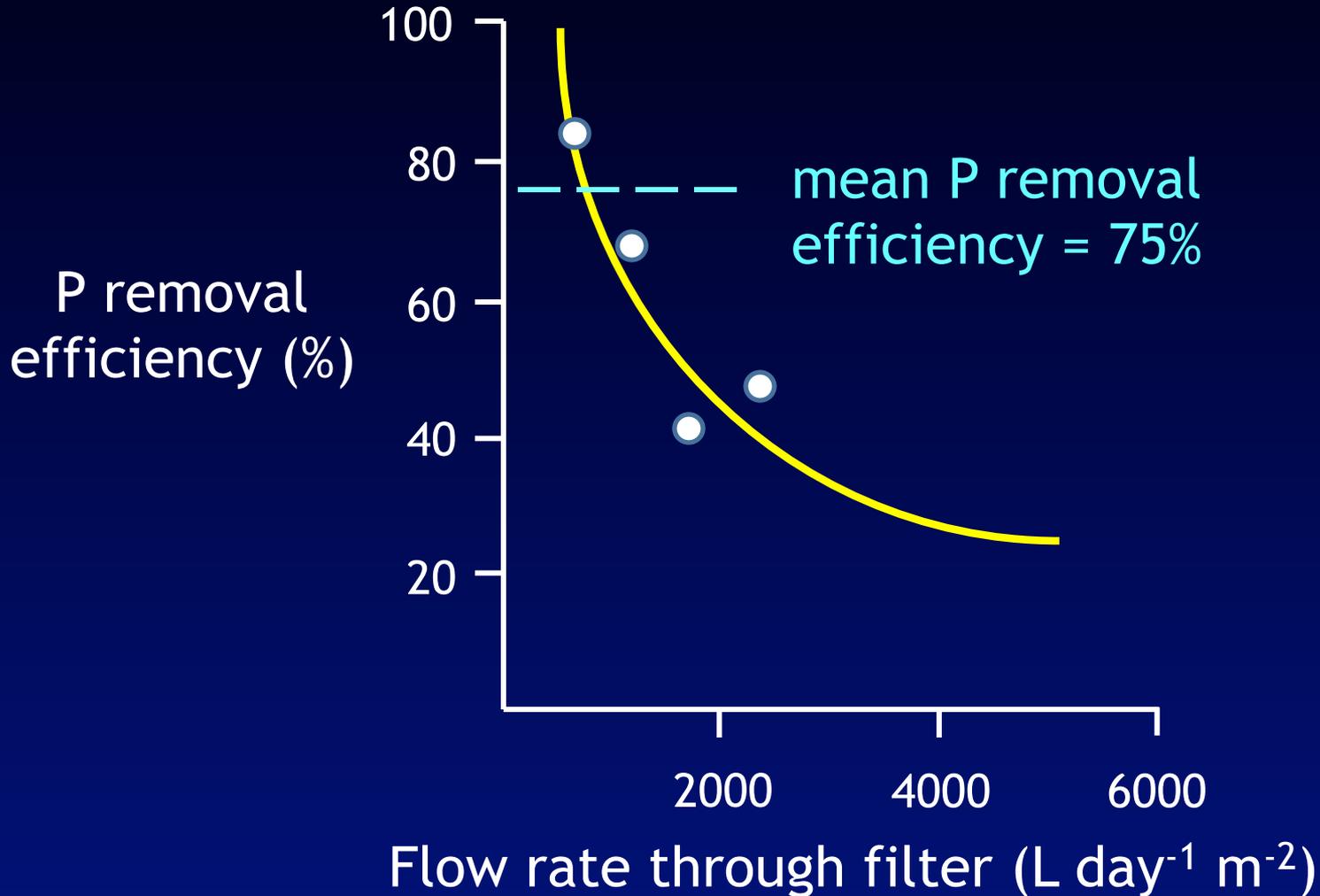
FGD gypsum "curtain" – 2nd generation



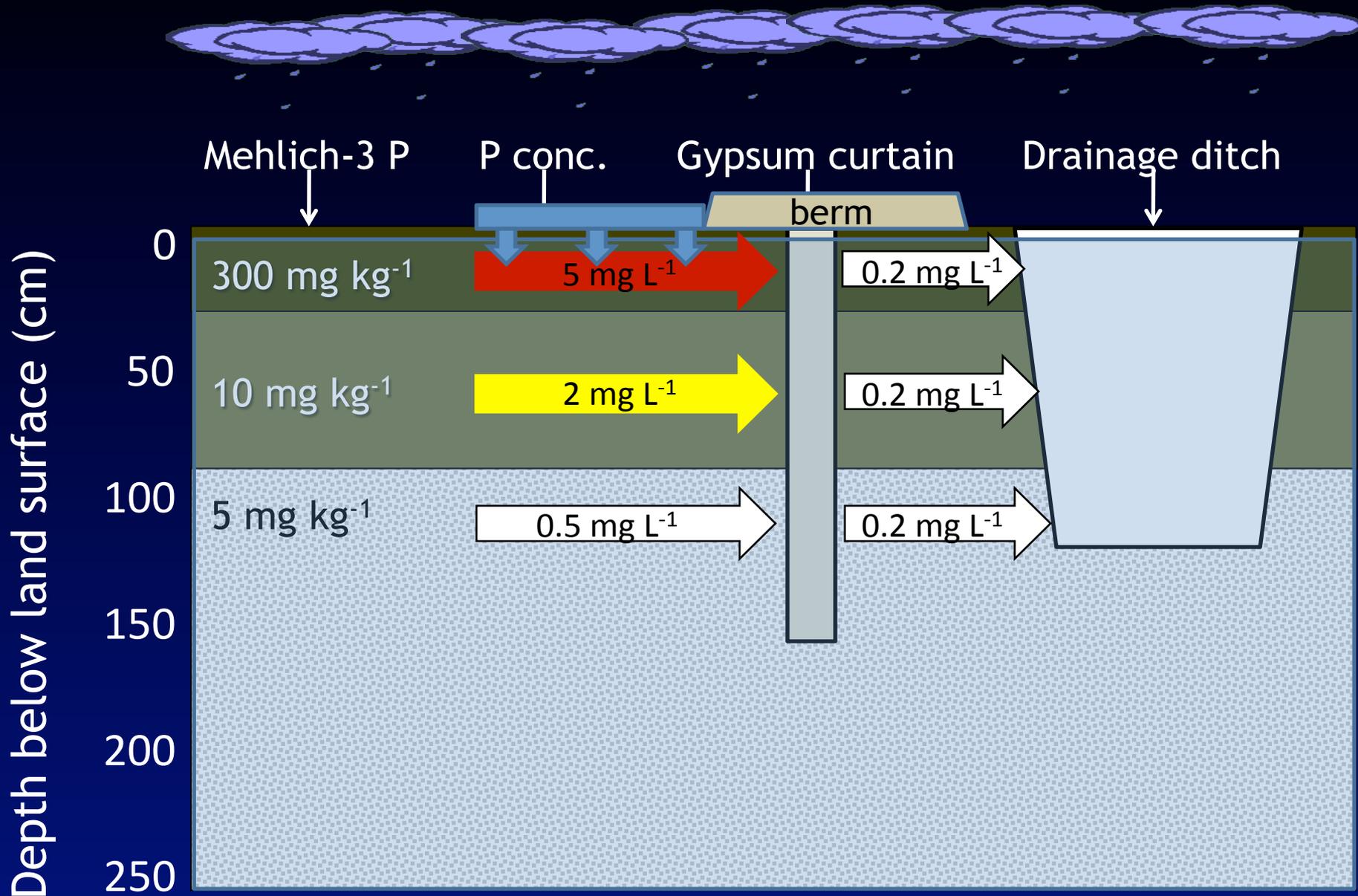
Nested piezometers for monitoring P concentration



P removal efficiency should be high (lateral groundwater flow is very slow)



FGD gypsum "curtain" - 2nd generation



FGD gypsum “curtain” - 2nd generation

Conservation Innovation Grant

UMES, ARS, UMCP,
Constellation Energy



\$1 M Natural Resources Conservation Service

\$1 M Constellation Energy (donated gypsum)

GOAL: Develop standards for gypsum curtains

Establish eligibility for cost share

Evaluate cost effectiveness

FGD gypsum “curtain” – 2nd generation

Applying the practice at a larger scale

20,000 tons of gypsum trucked from
Baltimore



Temporarily stored in litter sheds



FGD gypsum “curtain” – 2nd generation

Applying the practice at a larger scale

Trencher with one foot wide belt



Trailer style “Side Shooter”



FGD gypsum “curtain” – 2nd generation

Applying the practice at a larger scale

Automated samplers monitor ditch flow



Testing the benefits of land application

Improved infiltration and drainage
Lower dissolved phosphorus levels
Increased calcium and sulfur content



FGD gypsum “curtain” – 2nd generation

Applying the practice at a larger scale

Double ring infiltrometer measures gypsum effect on infiltration



Educating the next generation of water quality professionals



Environmental concerns?

- FGD gypsum contains small amounts of arsenic and mercury
- Arsenic in soil is sequestered by gypsum as Ca arsenate (arsenate behaves similar to phosphate)
- No detectable mercury loss in leachate (below drinking water levels)
- Burial prevents photoinduced mercury volatilization

Cost?

- No cost to producer / landowner
- Constellation Energy will donate gypsum
 - Value: \$15 per ton plus \$35 for transportation
 - One ton gypsum per 6 to 8 foot of trench
 - In 10 years (estimated life of gypsum curtain) one power plant produces sufficient gypsum to line all ditches in Maryland
- NRCS to cost share installation
 - Cost to be determined (currently \$2.50 / ft)

Questions?



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Q & A
with Dr. Torbert and Dr. Bryant



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Lunch



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United Soybean Board Research Update

Randall Reeder

