Development and Adoption of Measures to Prevent Off-site Nutrient Transfers

R. B. Bryant, P.J.A. Kleinman,
D.B. Jaynes, G.W. Feyereisen,
and J.A. Ippolito

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CEAP: What is the American public getting in return for their conservation dollars?

(a backward looking question, but CEAP is also forward looking)

CEAP is a multi-agency effort to quantify the environmental effects of conservation practices and programs and develop the science base for managing the agricultural landscape for environmental quality.

CEAP findings will be used to guide USDA conservation policy and program development and help conservationists, farmers and ranchers make more informed conservation decisions.

CEAP Vision... Enhanced natural resources and healthier ecosystems through improved conservation effectiveness and better management of agricultural landscapes.

CEAP Goal... To improve efficacy of conservation practices and programs by quantifying conservation effects and providing the science and education base needed to enrich conservation planning, implementation, management decisions, and policy.

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Case Studies

- Stream bank fencing – University Park (UP), PA
- Denitrification bioreactors for NO_3 removal in tile drainage – Ames, IA
- Gypsum filter for P removal – UP, PA
- Engineered wetlands for P removal – Kimberly, ID
- Innovations in manure application – UP, PA

Cannonsville Reservoir 1965

5,000 ac

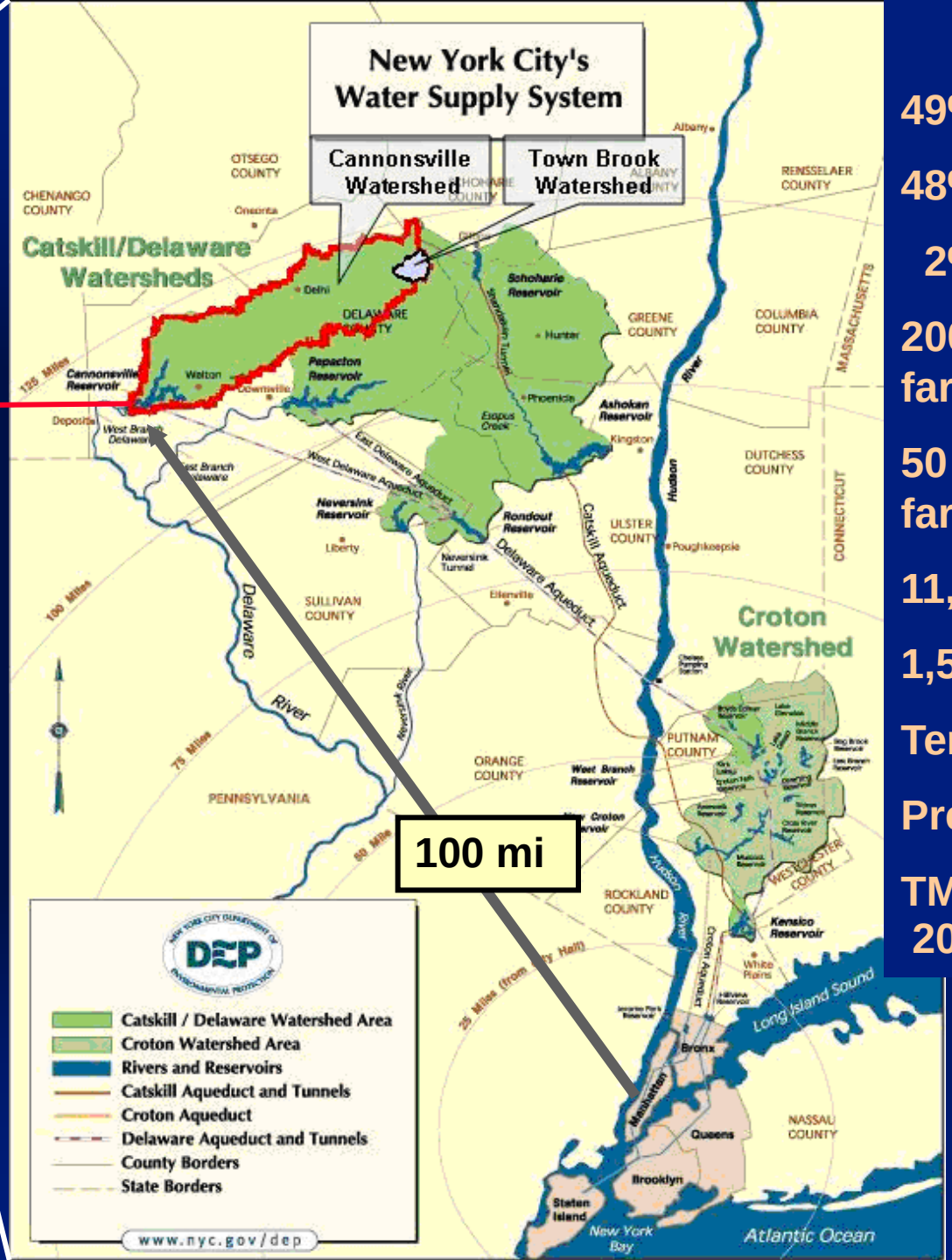
100 B gallons

Cannonsville Watershed

355 sq miles

Town Brook

14 sq miles



49% forest

48% grass

2% corn

200 large farms >$10K

50 small farms

11,000 dairy

1,500 beef

Temp 46 ^{o}F

Precip 45 in

TMDL:
20 µgP L-1

PSWMRU

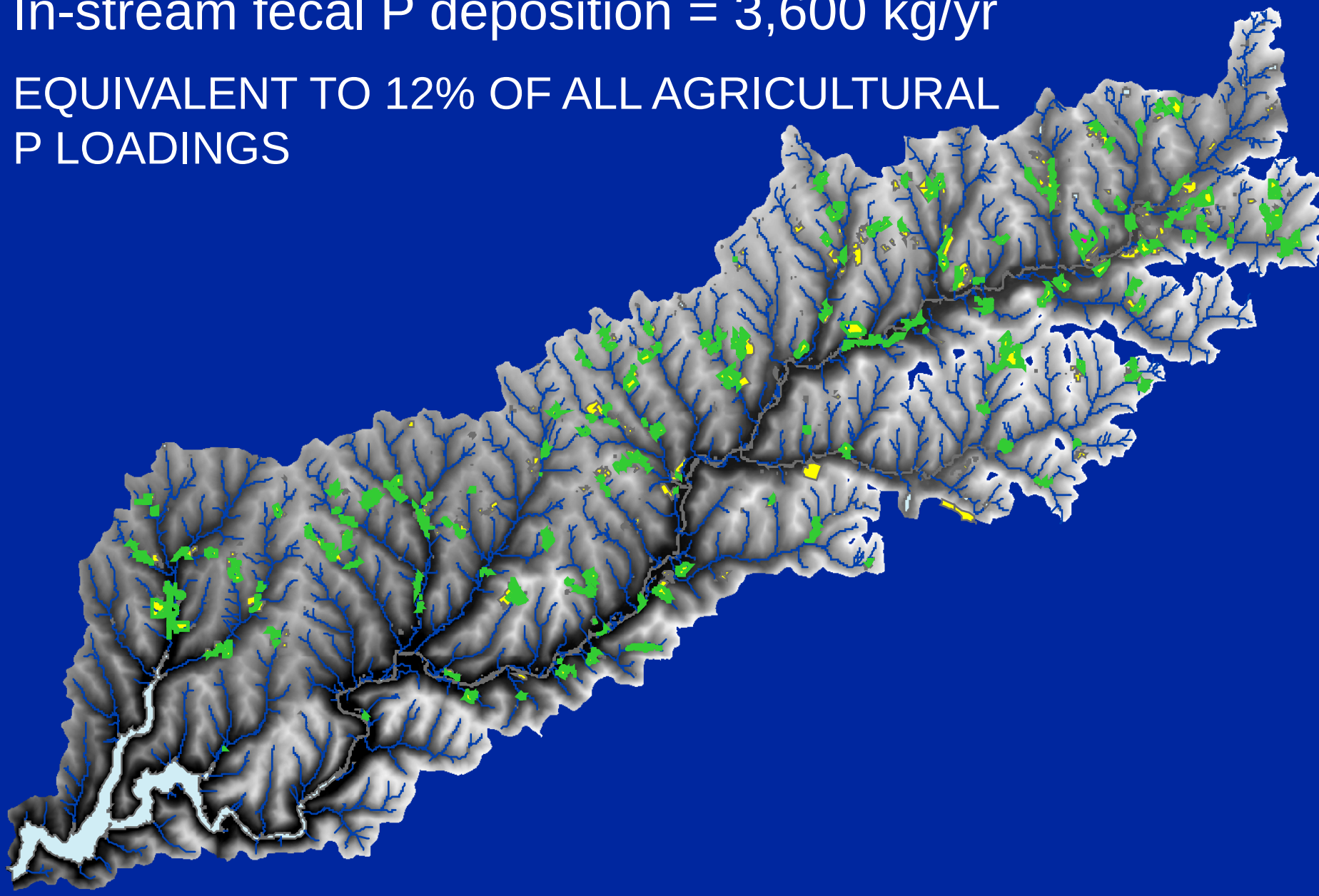
Cannonsville Watershed,
New York, USA
Problem: Farmer resistance to stream bank fencing

PSWMRU

2 g total P

In-stream fecal P deposition = 3,600 kg/yr

EQUIVALENT TO 12% OF ALL AGRICULTURAL P LOADINGS



Steps in the Development of Denitrification Bioreactors for Removal of NO_3 in Tile Drainage

- Proof of concept
- Research to optimize design and determine efficacy
- Develop NRCS Conservation Practice Interim Standard
- Demonstration Projects and Training
- Issuance of NRCS Conservation Practice Standard and Modification of Standard by Individual States

Proof of Concept

Blowes, D.W., W.D. Robertson, C.J. Ptacek, and C. Merkley. 1994. Removal of agricultural nitrate from tile-drainage effluent water using in-line bioreactors. J. Contam. Hydrol. 15:207–221.

- a 200-L bioreactor removed nearly all NO_3 from field drainage water with concentration of 3 to 6 mg N L^{-1}.

Robertson, W.D., and J.A. Cherry. 1995. In situ denitrification of septic-system nitrate using reactive porous media barriers: Field trials. Ground Water 33:99–111.

- a bioreactor trench containing coarse sawdust reduced very high NO_3 concentrations (57–62 mg N L^{-1}) to much lower concentrations (2–25 mg N L^{-1})

Research to optimize design and determine efficacy

Carbon Source

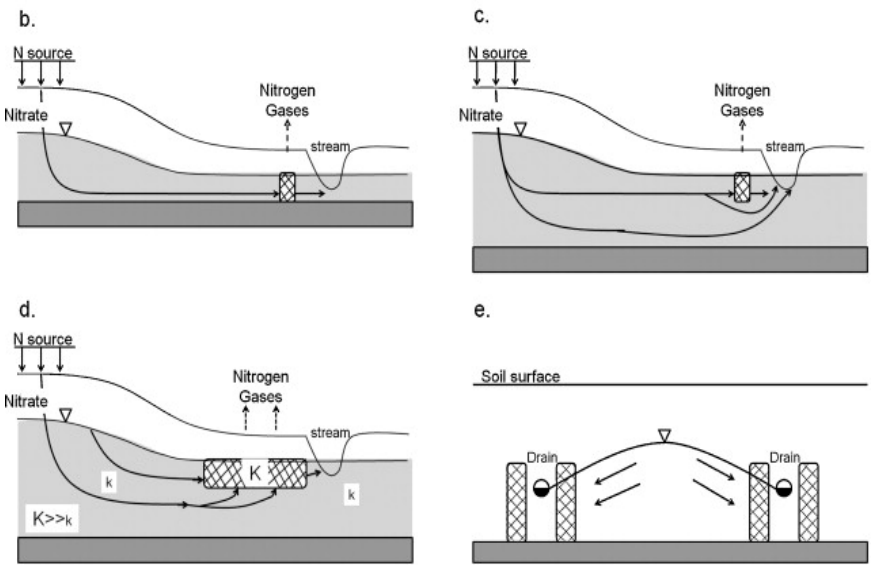
- Any labile C source will work
- But need to optimize denitrification rate
- While maximizing life expectancy
- Woodchips have been ID'ed as ideal source

Bioreactor Design

- Beds, trenches, walls all work
- Need to identify optimum design for specific purpose
- Need to maximize denitrification

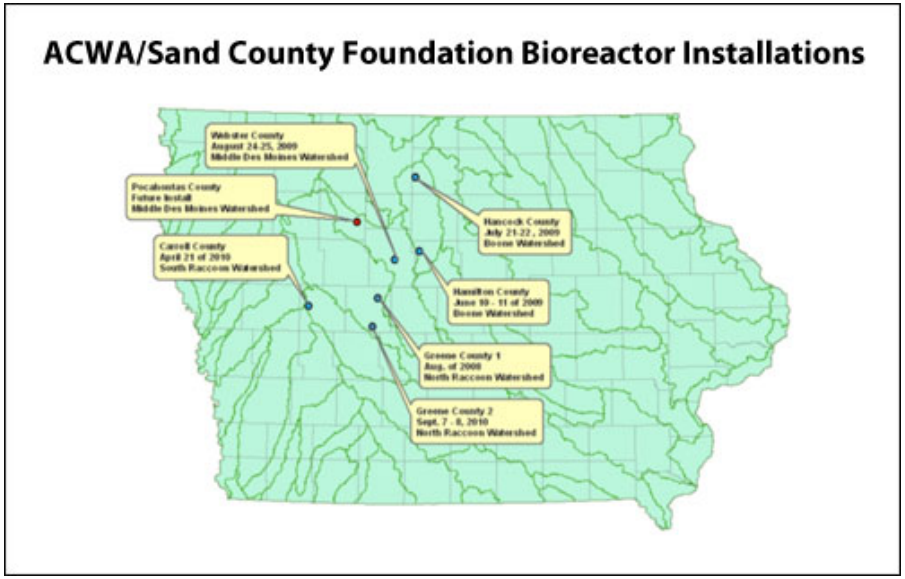
Determine Practice Cost

- \$ per kg NO_3 removed
- Compare to other WQ practices
- Bioreactors are as cost effective for removing NO_3 as wetlands



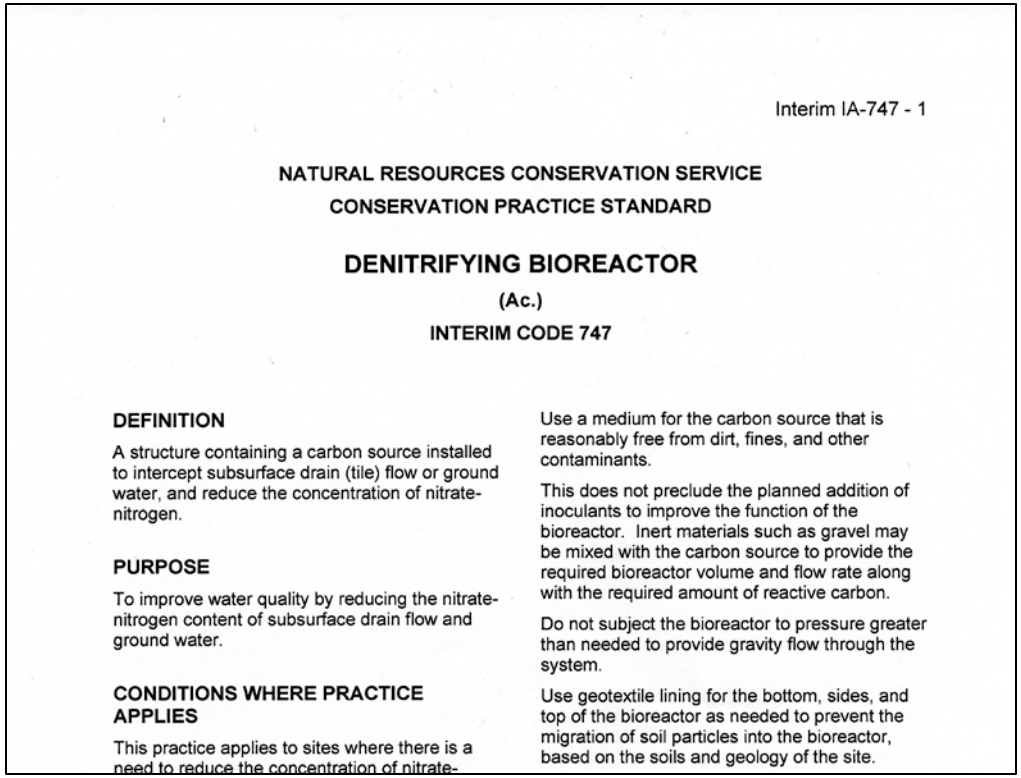
Demonstration Projects and Training

- Demonstration projects are a useful and often necessary tool to show potential users that the technology will work under their local conditions.
- The projects can also be used as training exercises for farmers, technical service providers, and contractors.
- Monitoring data can be used to refine interim Practice Standard



Develop Conservation Practice Standard

- Development of an Interim Conservation Practice Standard can provide information to Technical Service Providers and NRCS personnel
- The Interim Standard can serve as basis for cost sharing the practice
- The Interim Standard needs to be revised within 3 yr of issuance.
- The Final Conservation Practice Standard can be further modified by individual states for local conditions.



Interim IA-747 - 1

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

DENITRIFYING BIOREACTOR

(Ac.)

INTERIM CODE 747

DEFINITION

A structure containing a carbon source installed to intercept subsurface drain (tile) flow or ground water, and reduce the concentration of nitrate-nitrogen.

PURPOSE

To improve water quality by reducing the nitrate-nitrogen content of subsurface drain flow and ground water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sites where there is a need to reduce the concentration of nitrate-

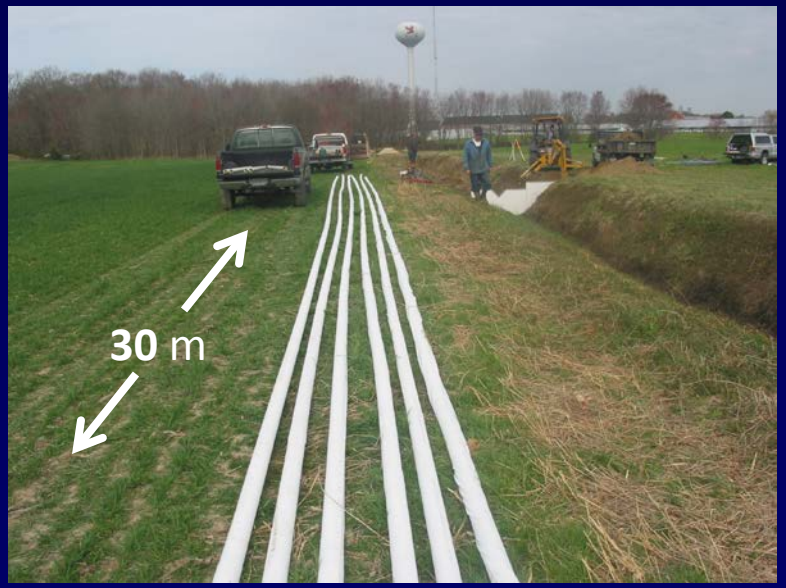
Use a medium for the carbon source that is reasonably free from dirt, fines, and other contaminants.

This does not preclude the planned addition of inoculants to improve the function of the bioreactor. Inert materials such as gravel may be mixed with the carbon source to provide the required bioreactor volume and flow rate along with the required amount of reactive carbon.

Do not subject the bioreactor to pressure greater than needed to provide gravity flow through the system.

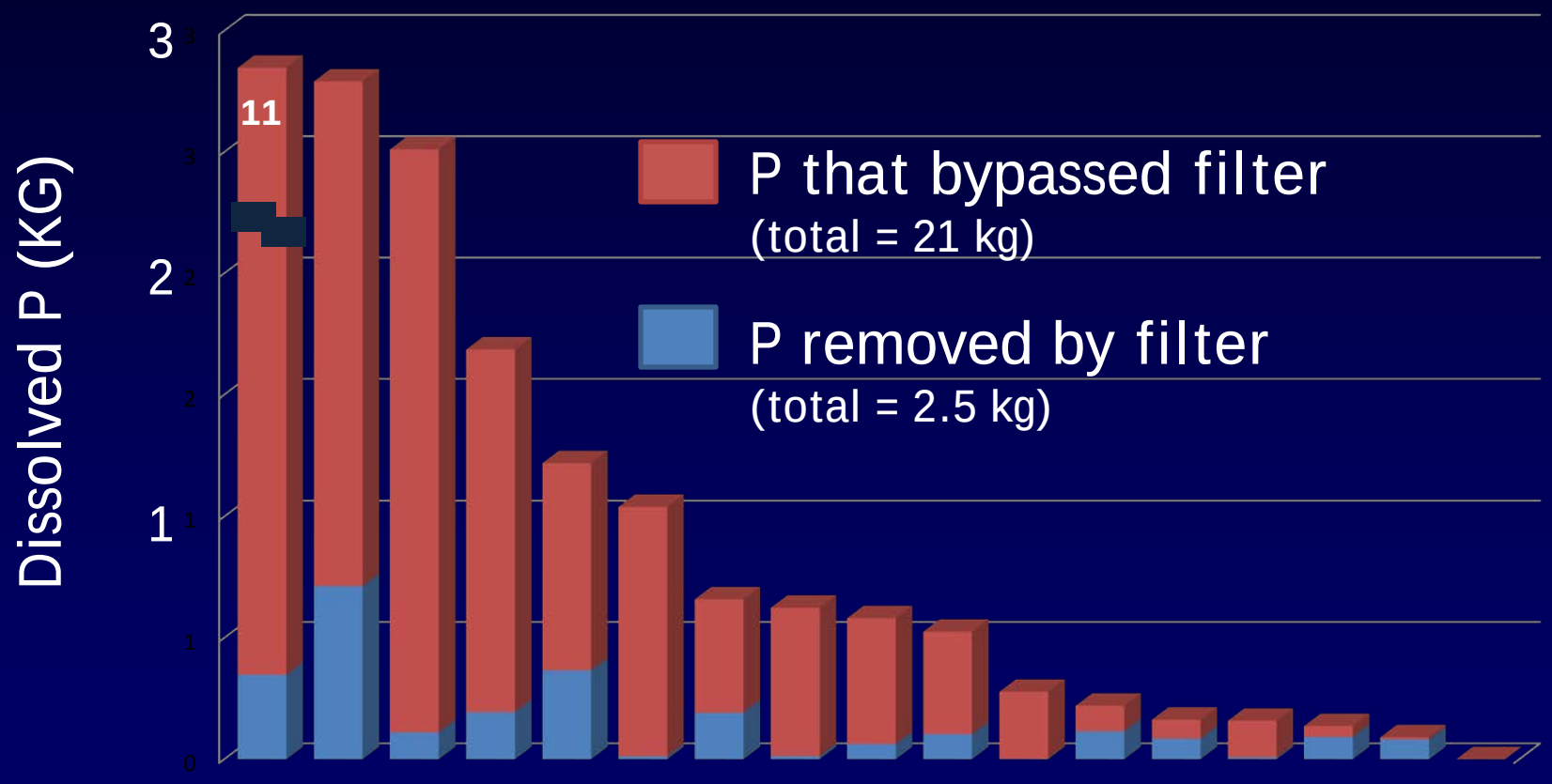
Use geotextile lining for the bottom, sides, and top of the bioreactor as needed to prevent the migration of soil particles into the bioreactor, based on the soils and geology of the site.

FGD gypsum filter – 1st generation

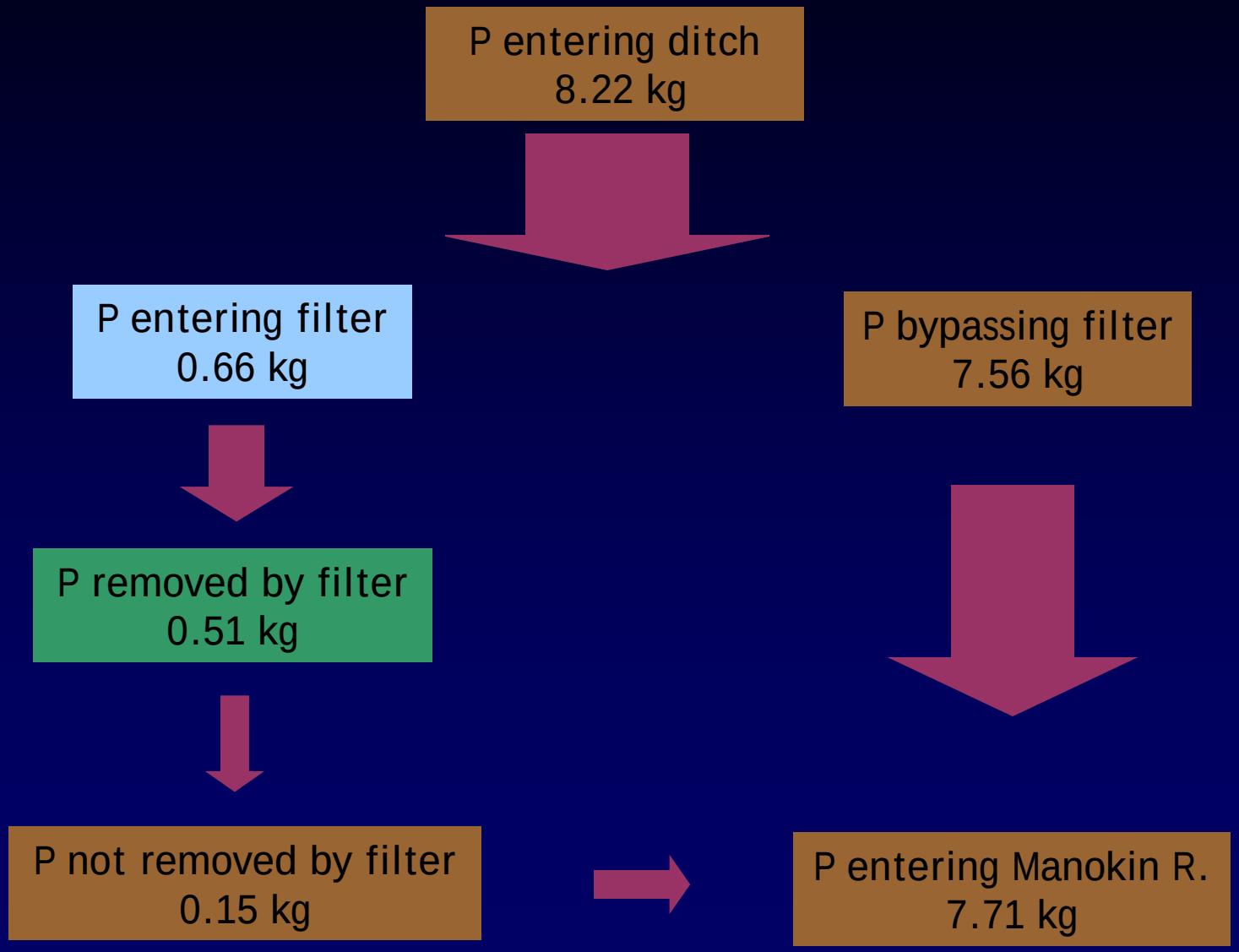


P Removal by filtration

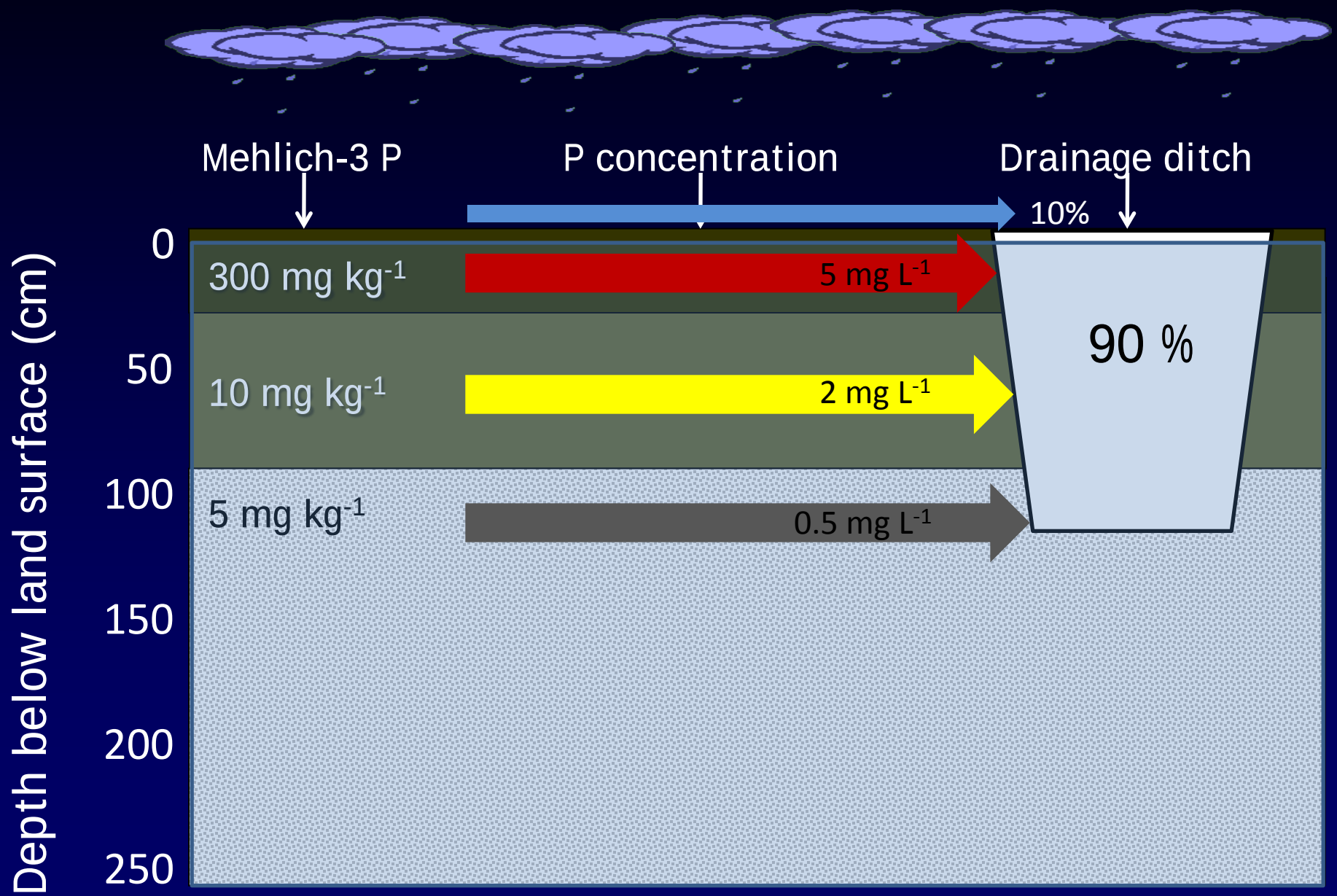
Dissolved P loads in 17 storm events



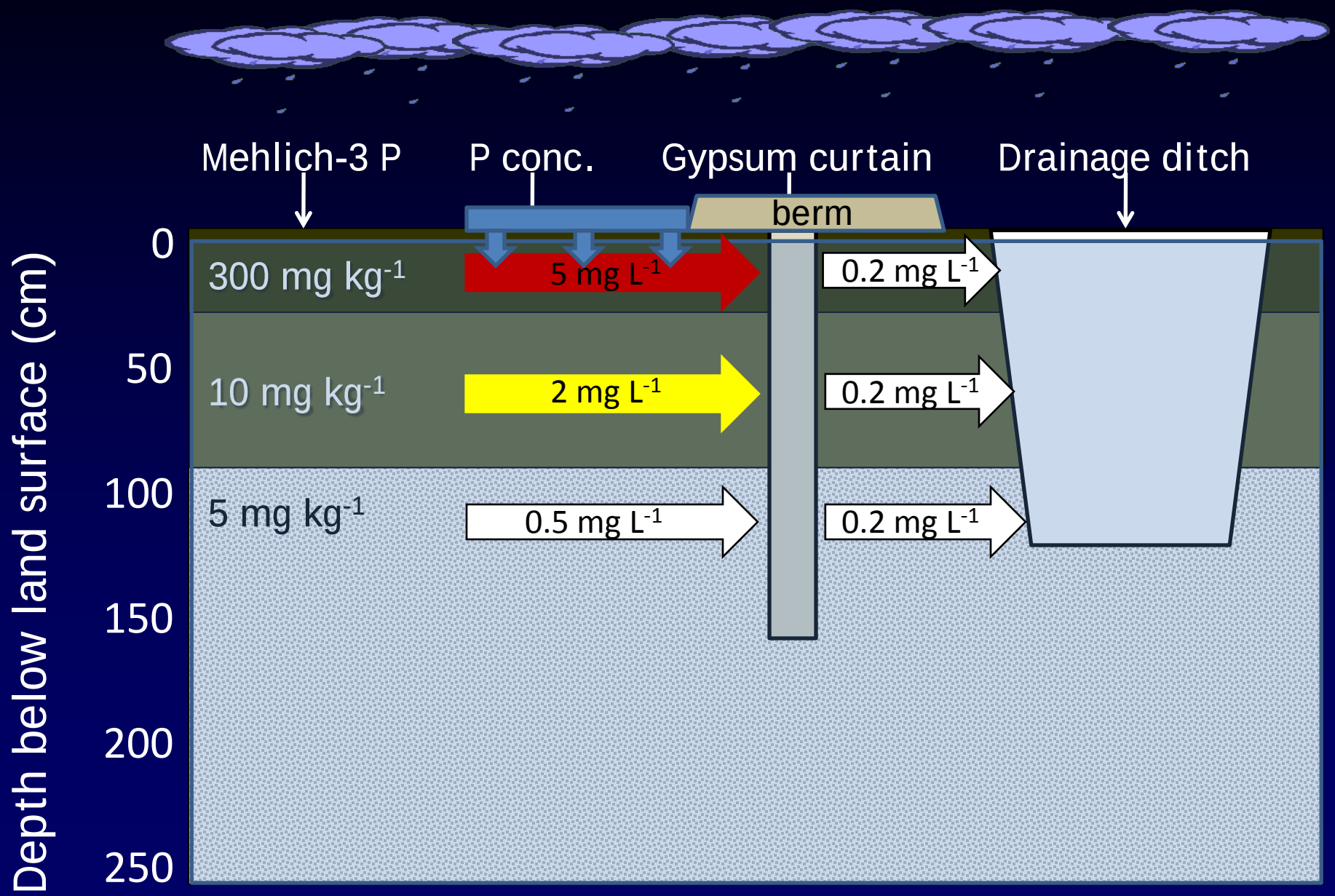
P removal by gypsum filter for April 18, 2007 Storm event: 3.31 inches of rain in 30 hrs.



P transport processes in Coastal Plain soils

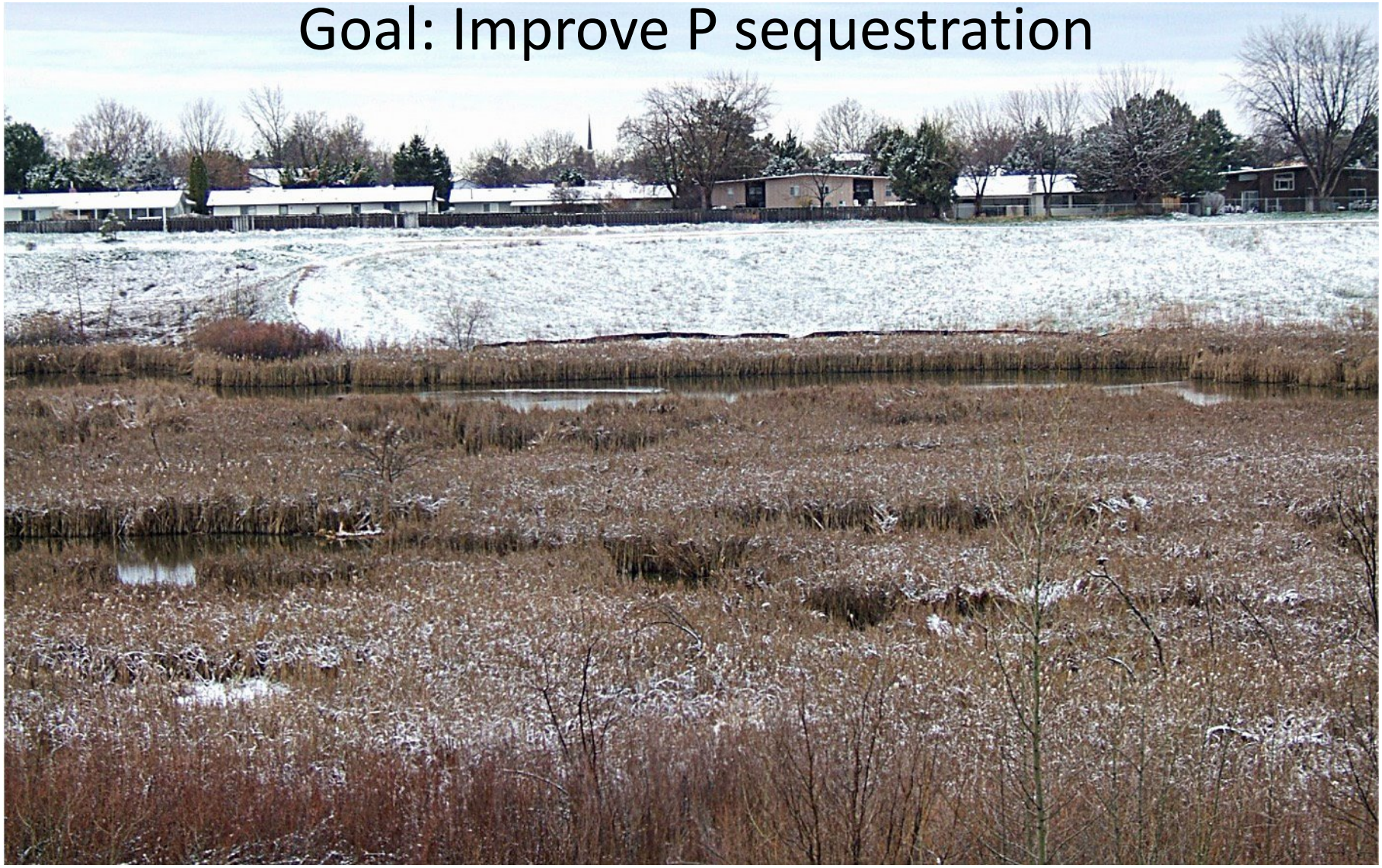


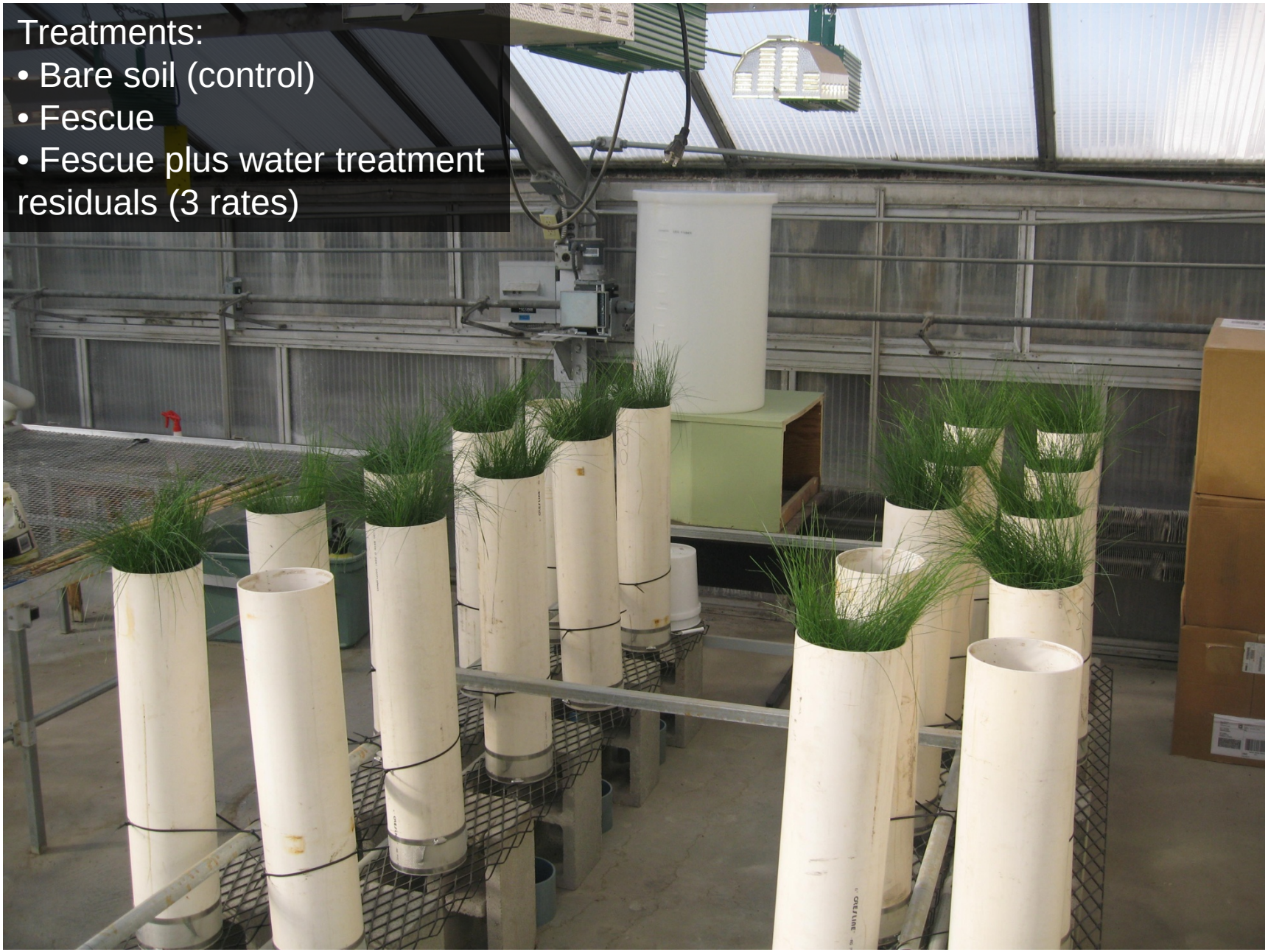
FGD gypsum "curtain" – 2nd generation



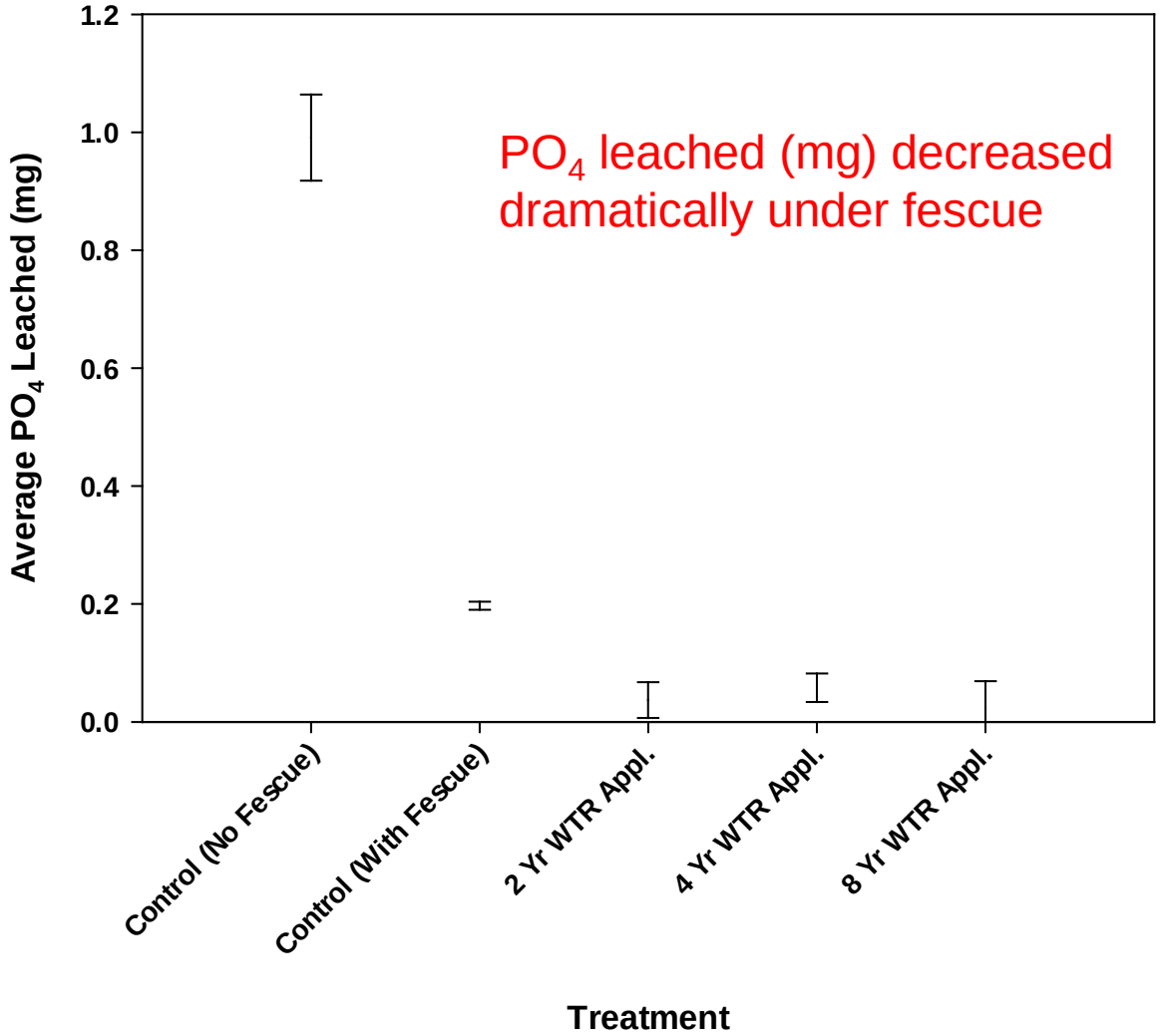
FGD gypsum "curtain" – 2nd generation

Engineered Wetlands: Boise, ID
Goal: Improve P sequestration

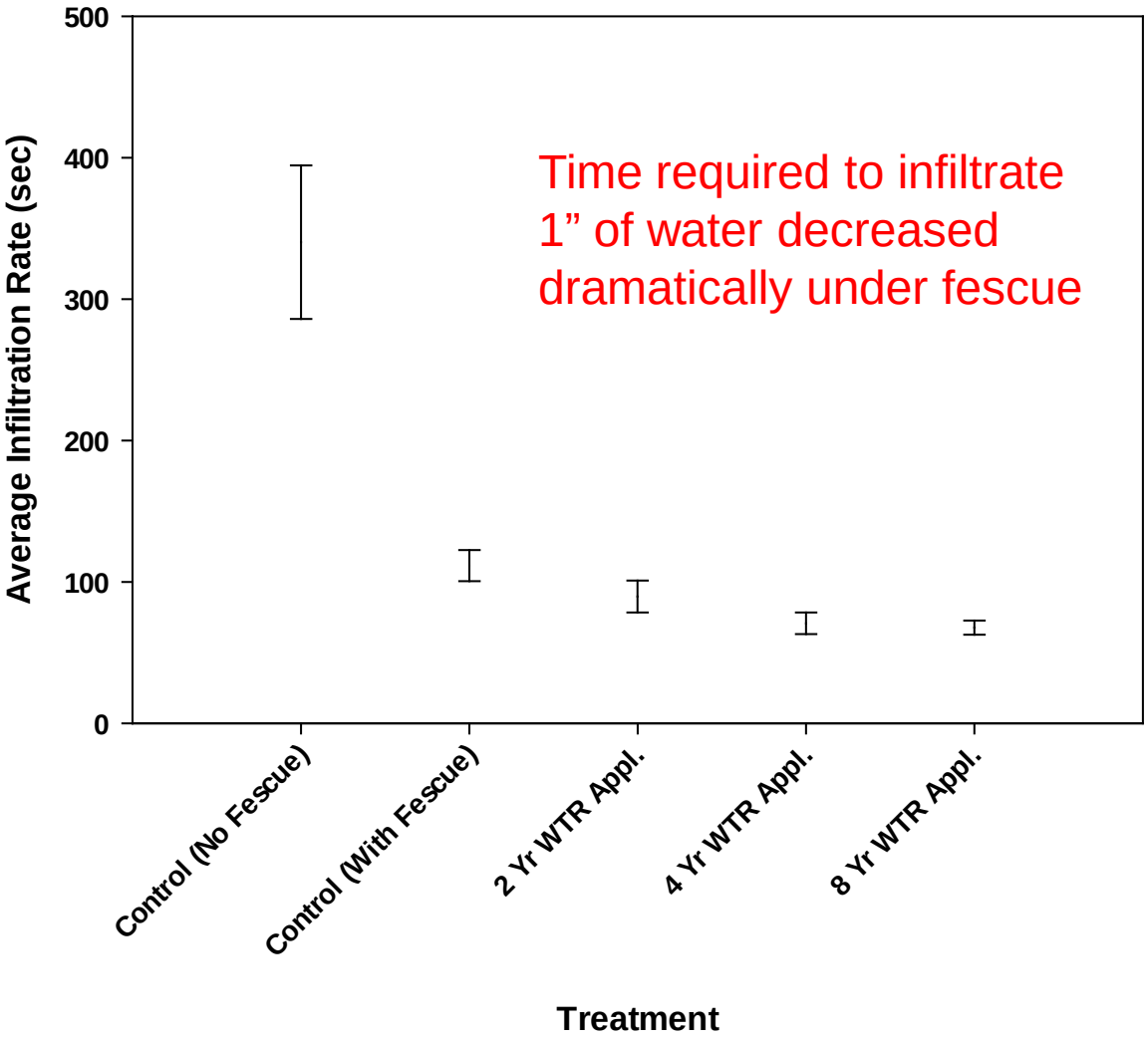



Treatments:
• Bare soil (control)
• Fescue
• Fescue plus water treatment residuals (3 rates)

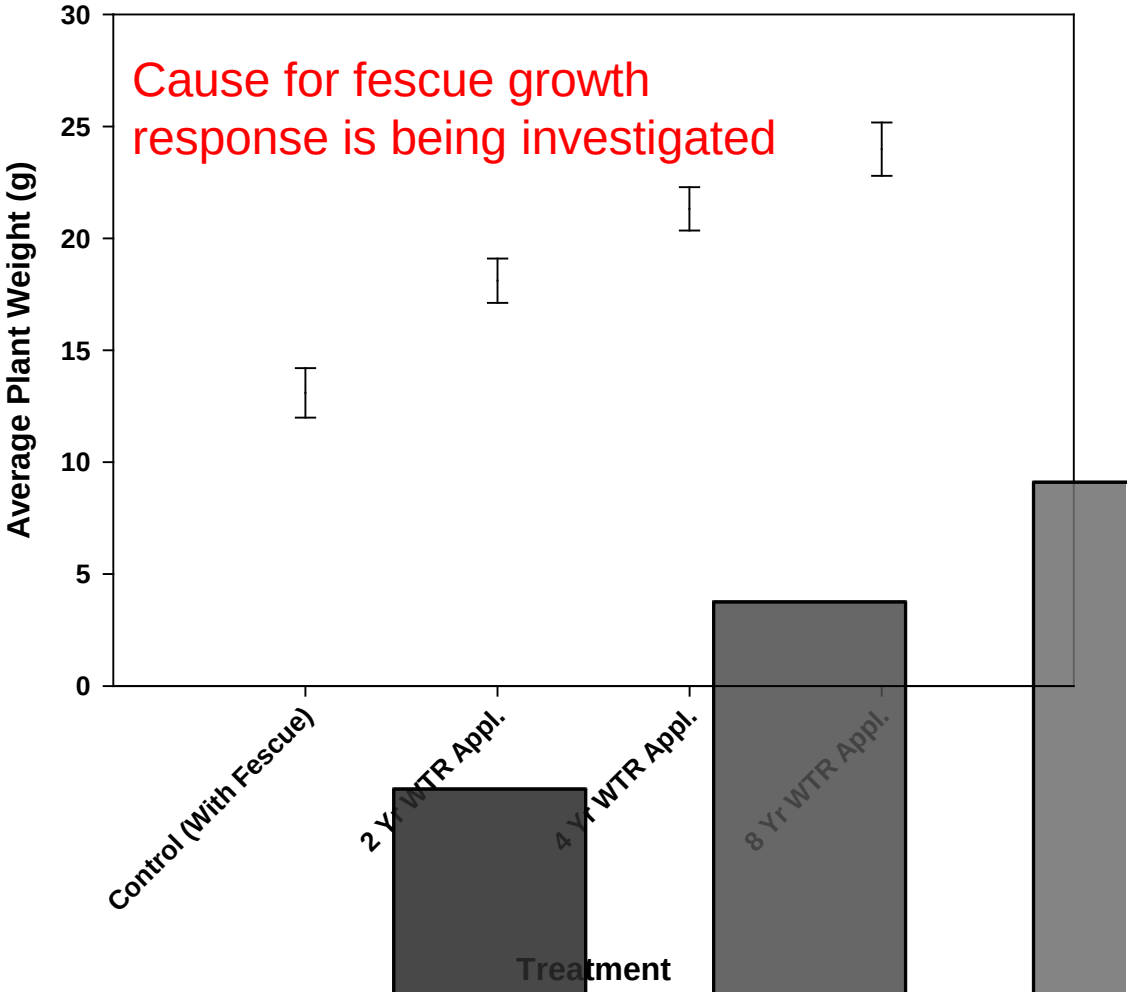
Average PO_4 (mg) Leached Over the 3 Month Column Study



Average 1" Infiltration Rates Over the 3 Month Column Study



Average Plant Weight
Over the 3 Month Column Study



Fast Track

Based on the results of this study, the municipality of Boise, ID is going forward with construction of the engineered wetland to treat storm runoff.

Liquid manure application trials – no-till corn

PDA, USDA-CIG, PA Pork Producers grants

Broadcast

Tillage

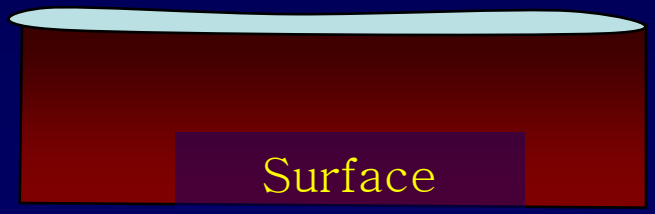
Aerator

Shallow disk

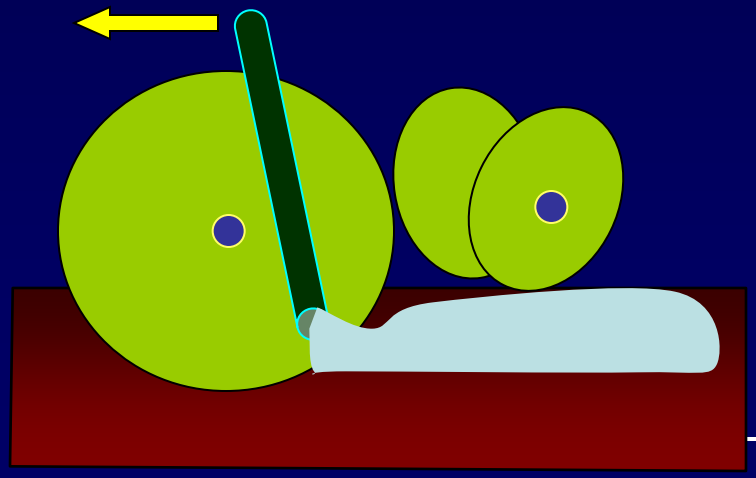
Anti-leaching sweeps

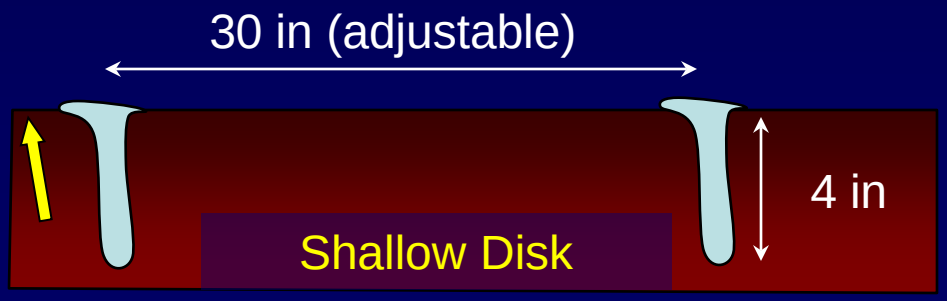
High pressure

Broadcast application

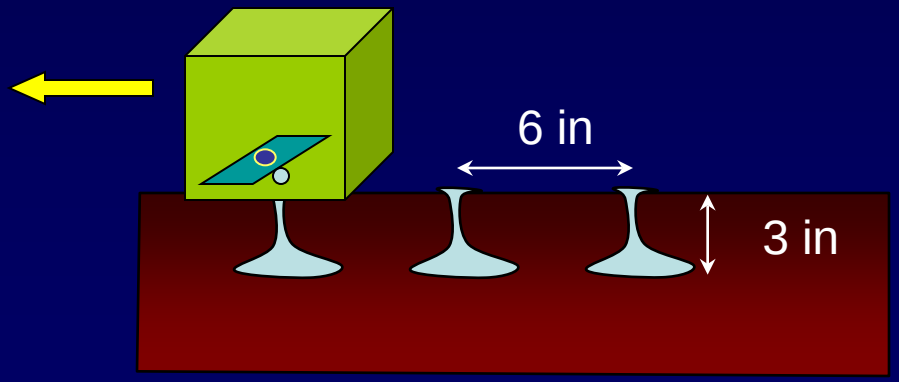


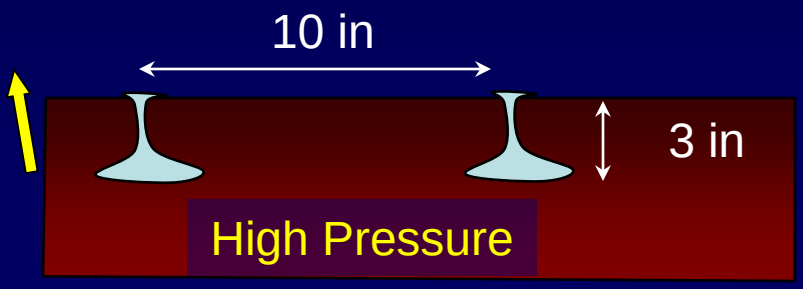
Shallow disk injection





High pressure injection

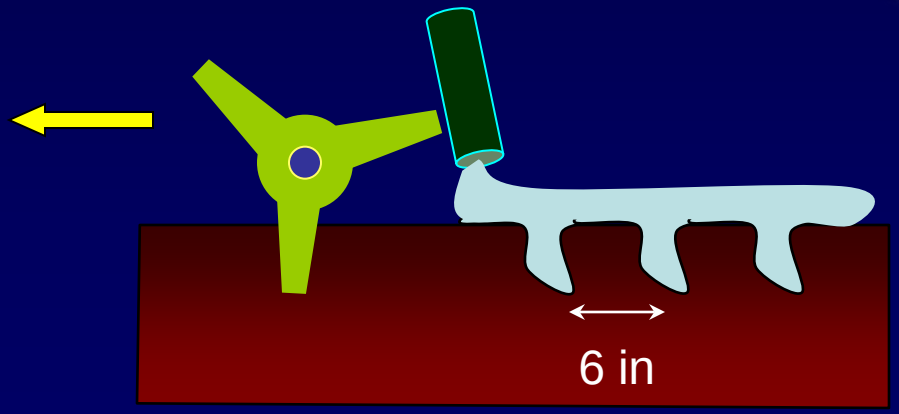


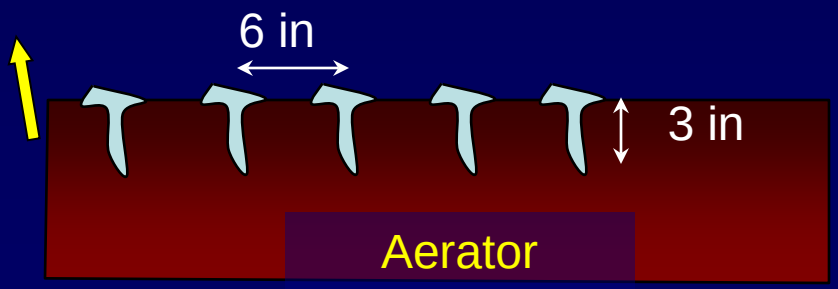


Aerator w/banded manure

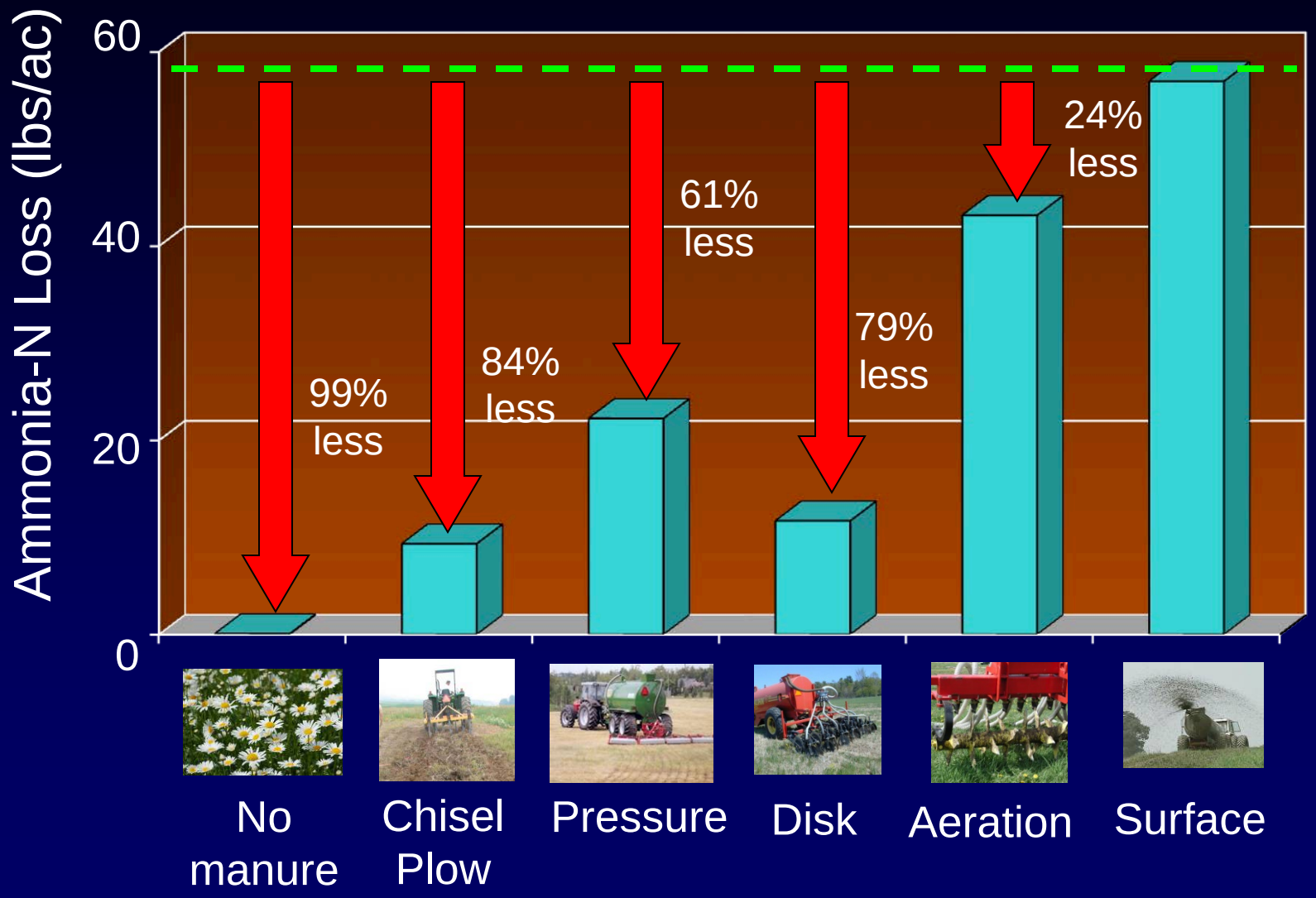
No manure

6000 gal/ac





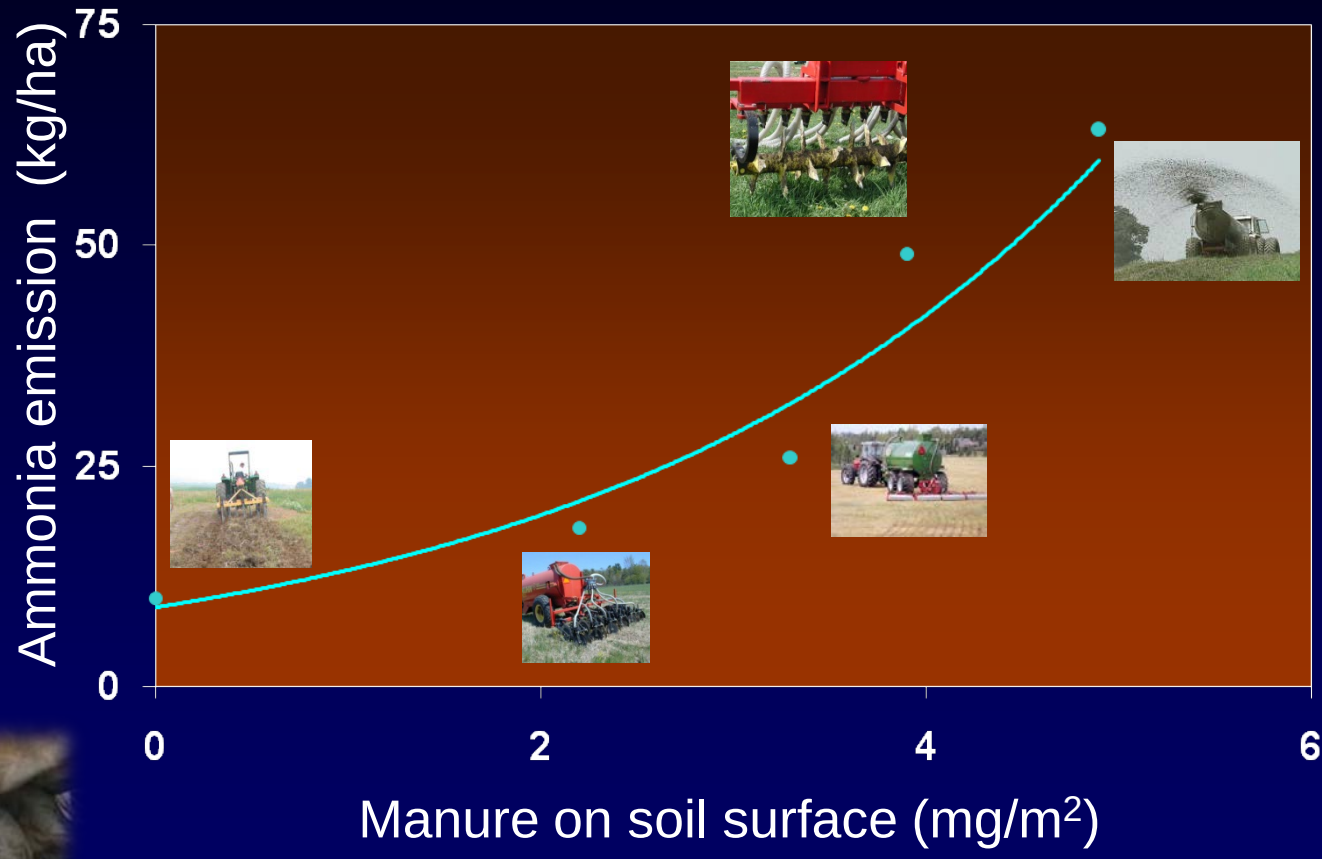
Rock Springs Trials (2006-2007 average)



Data courtesy C. Dell, USDA-ARS

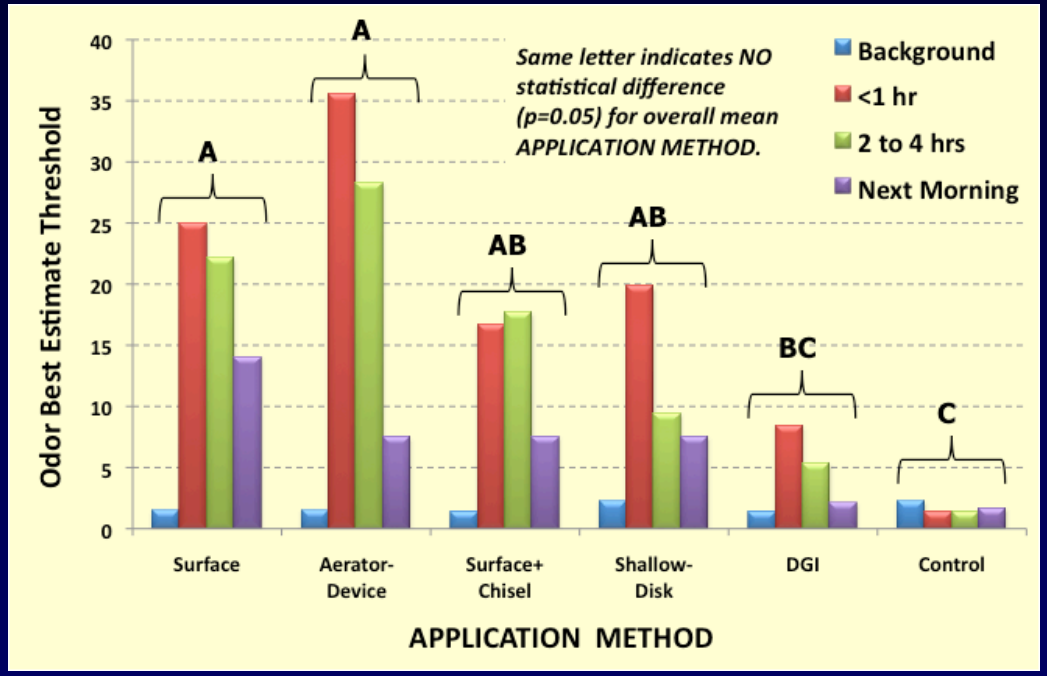
USDA UNITED STATES DEPARTMENT OF AGRICULTURE

Ammonia: more manure on the surface, more ammonia emitted



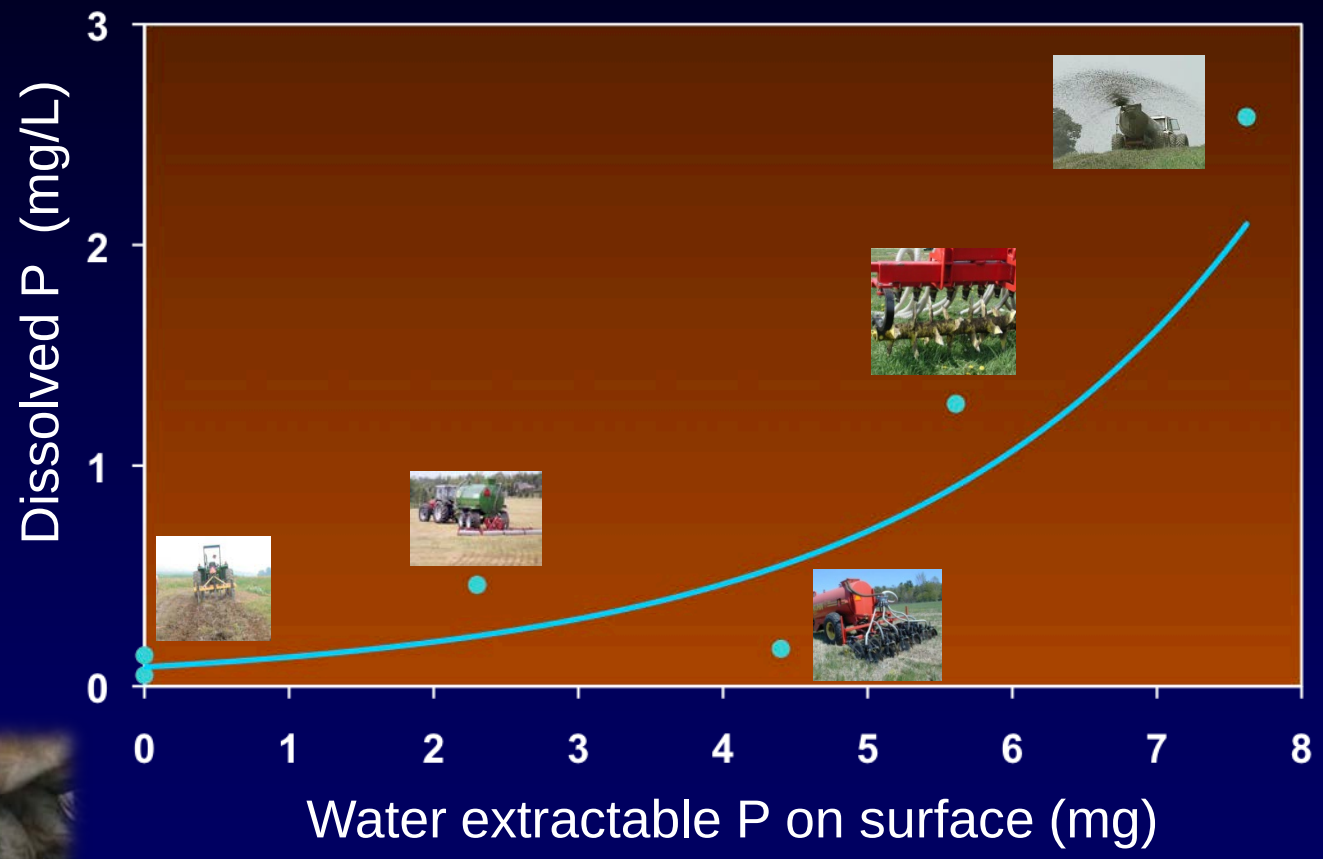
Data courtesy C. Dell, USDA-ARS

Odor – similar (but not identical) to ammonia



Penn State odor panel

Phosphorus: more on the surface, more dissolved phosphorus in runoff



Broadcast

Tillage

Aerator

Shallow disk

Anti-leaching sweeps

High pressure

Producers use these results to choose the manure applicator that is best suited for their soil conditions and management objectives.

Conclusion

- In some cases, conventional conservation practices alone cannot meet environmental goals.
- Innovations in conservation are needed in order to advance agroecosystem services while intensifying production.

Questions?