NEIWPCC Research Webinar
October 15, 2015

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Today's Presenter

Eric Howe

- Environmental Analyst at NEIWPCC/Lake Champlain Basin Program (LCBP) since 2009
- Coordinates the LCBP Technical Advisory Committee
- Manages Basin-oriented research grants and local-level implementation grants
- Project Officer for research grants such as agricultural Edge of Field monitoring projects, fish passage projects, mercury analysis in sportfish, economic valuation of Lake Champlain

Today's Presenter

Fletcher (Kip) Potter

- Water Quality Specialist with USDA/NRCS in Colchester, VT
- Coordinates Vermont NRCS projects and programs with state and federal partners, including:
  - Edge of field monitoring of agricultural conservation practices
  - Watershed planning in targeted watersheds
  - Prioritizing NRCS practices to meet water quality goals
  - Development of new practices to address emerging issues
- 25 years of experience with NRCS, 35 in water related work
- Ph.D. in Forest Hydrology from Penn State

Tile Drainage: The Vermont Perspective

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Fletcher (Kip) Potter
Water Quality Specialist
Colchester, VT

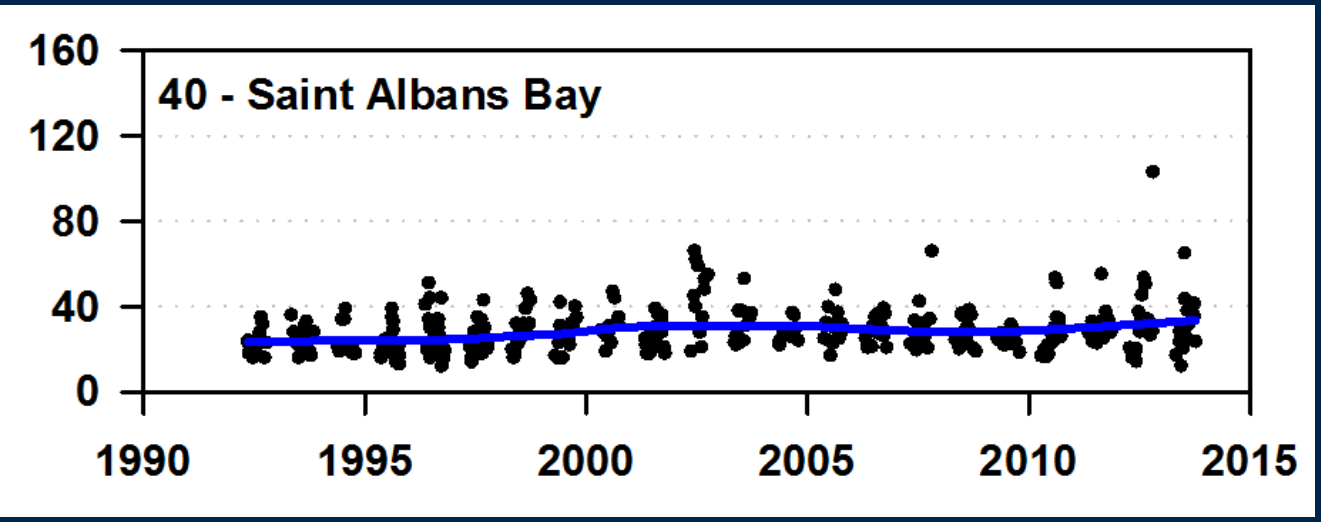
What We Know - Overview

- Soluble Phosphorus is readily available for plant/algae growth, compared to only 40 to 80 percent of Total Phosphorus (some of which is soluble phosphorus)
- Past conservation efforts in Vermont have focused on controlling Phosphorus (P) loading by reducing erosion in surface runoff
- Most P reporting has focused on Total Phosphorus (TP), trends in soluble P have been largely ignored
- Overall, installing tile drainage may reduce P loading in some situations and increase it in other situations

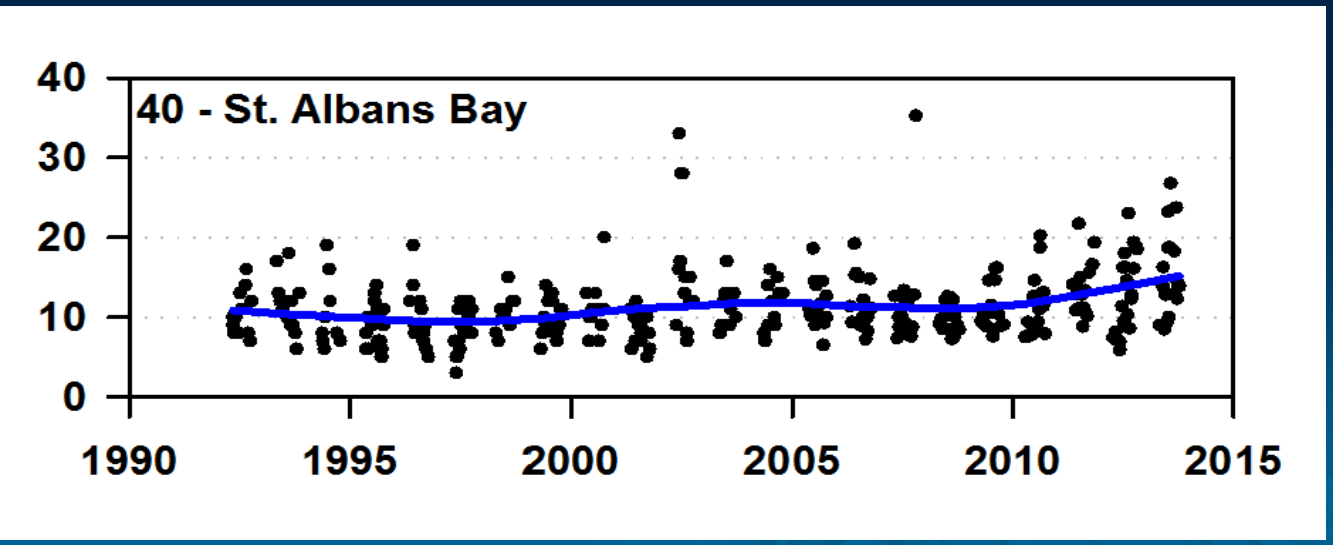
What We Know - Vermont

- Heavy soils are common within the Champlain Valley, especially Addison, Rutland and Franklin Counties (over 86,000 ac. in Franklin County)
- Surface drainage of ag fields is common throughout the Basin, both in floodplains and upland areas
- In some watersheds more than 50% of ag fields may be tile drained
- Tile drainage is being installed at an accelerated rate in the LCB, including on fields under reduced tillage practices, on heavy clays and even on more moderately well drained soils
- New tile drainage systems are usually laid out in more intensive grid systems

Trends in TP and Soluble P (TDP) in St. Albans Bay



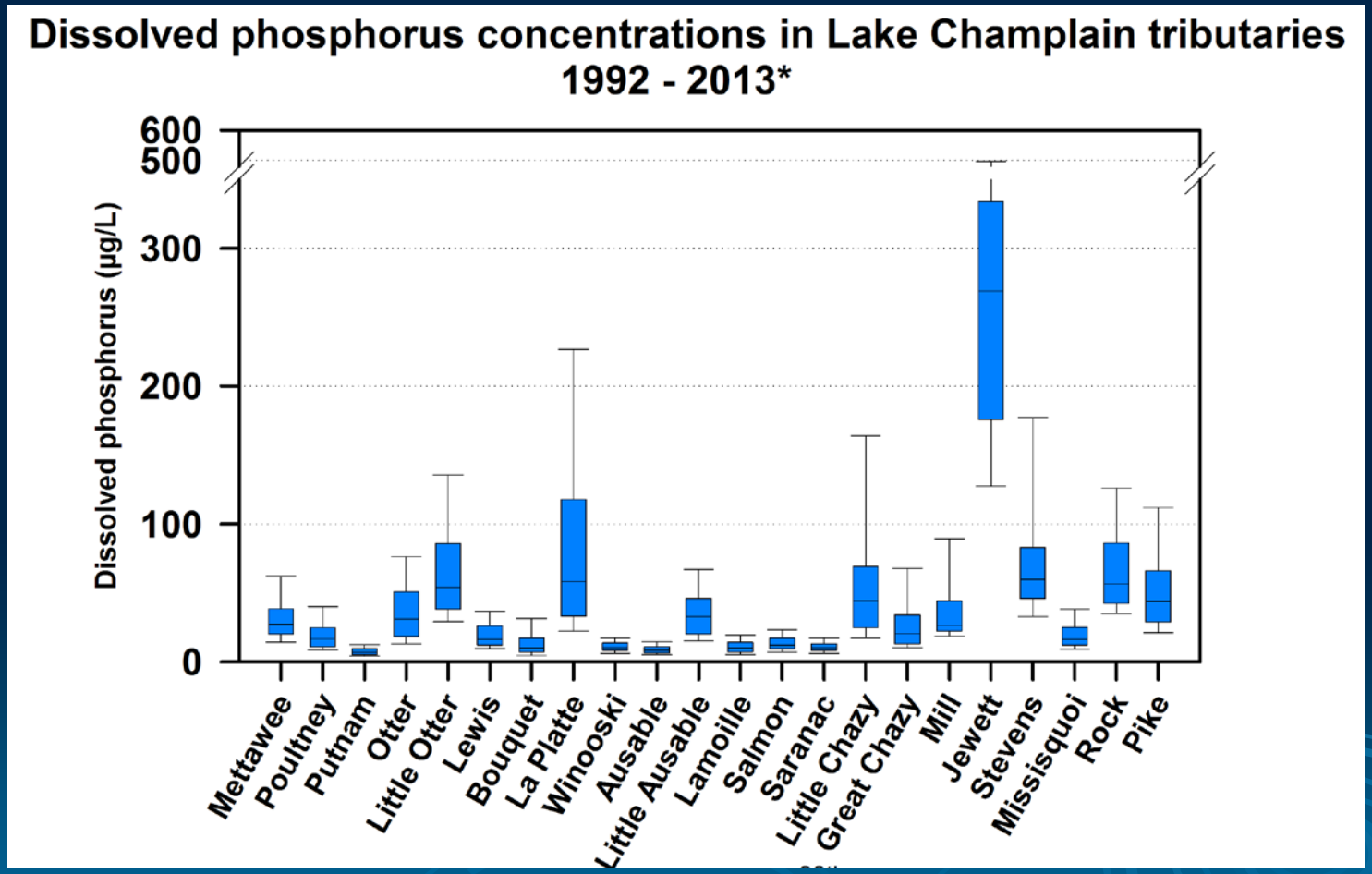
Total Phosphorus (TP) Concentrations (a 7% increase over last 5 years)



Soluble Phosphorus (TDP) Concentrations (a 20% increase over the last 5 years)

Source: VTDEC LC Long-term Monitoring Program

Soluble Phosphorus Concentrations (TDP) in Lake Champlain Tributaries



*Not all tributaries have data for this entire period

Source: VTDEC LC Long-term Monitoring Program

Modern Tiling Equipment

- All equipment is automated
- Uses high resolution GPS and laser leveling
- Total tiling package (inc. an ATV with advanced GPS) is close to $1 million
- Operators can install up to 32,000 ft of tile (6 miles) in a weekend

Example of Tile Drainage in Fields in the St. Albans Bay Watershed (Bing 2013 Imagery)

Example of Tile Drainage in Fields in the St. Albans Bay Watershed (Bing 2013 Imagery)

Recently Tiled Field

Surface Water can Enter Tile Drainage Systems Quickly through Preferential Flow Paths

Tile Line Smoke Tests

Smoking Wormholes (Macropores)

Courtesy Stephen Kramer, Miner Institute

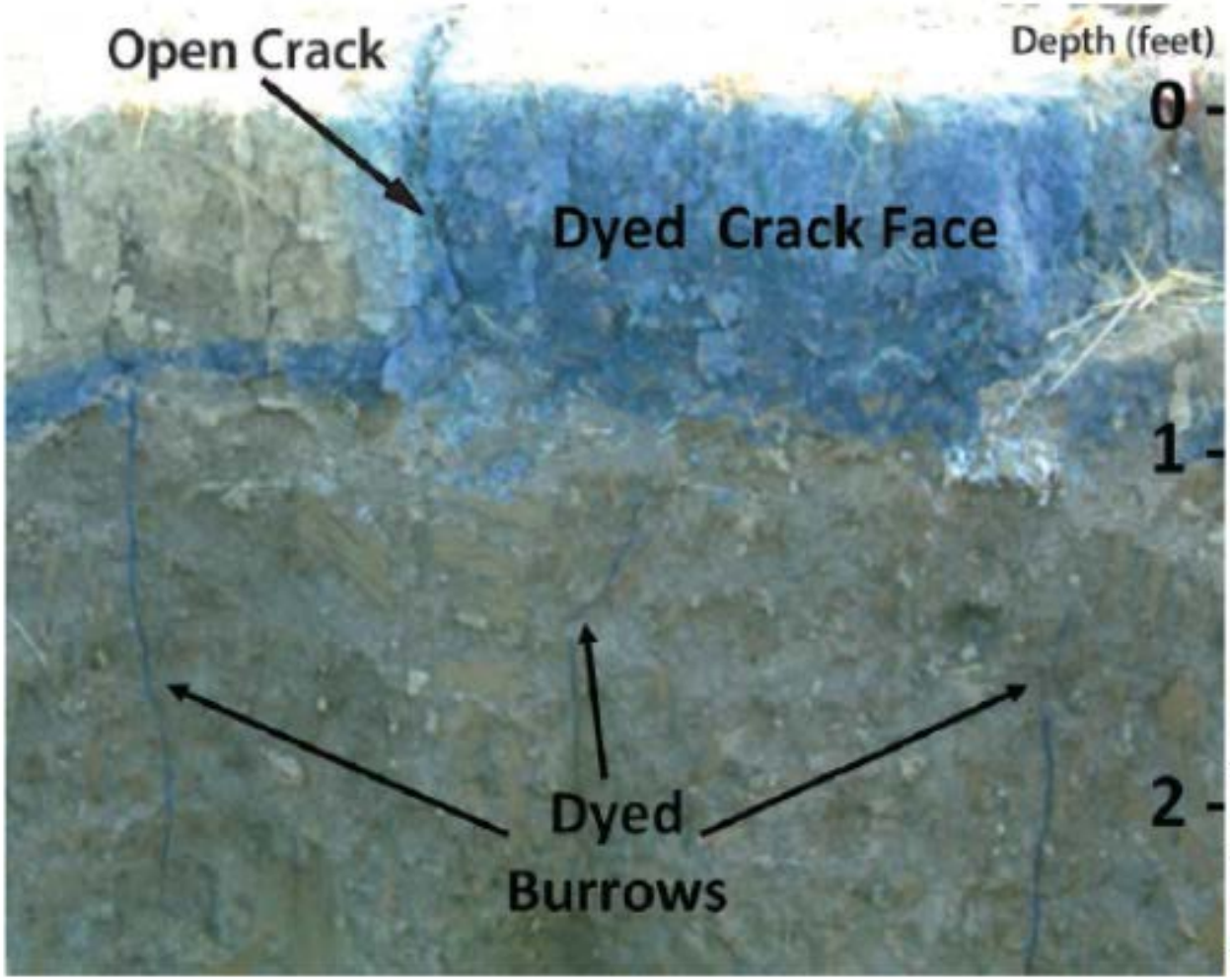


Figure 1. Methylene blue dye flowing through preferential flow paths in the soil.

Courtesy Matt Ruark, University of Wisconsin

Phosphorus Concentrations in Tile Drainage

- Literature Phosphorus (TP and DRP) concentrations range from around 100 ug/l up to 4,640 ug/l
- Limited samples from Vermont range from 20 to 1,100 ug/l Total Phosphorus (TP and DRP)
- Lower compared to VT EoF TP in Surface Runoff
  - EMC's range from 68 to 15,560 ug/l
  - Overall Average EMC for TP = 511 ug/l
- In lake goal for Missisquoi Bay is 25 ug/l TP
- New VT in-stream standard for medium gradient streams in ag areas is 27 ug/l TP (at baseflow conditions)

Field Level Studies
(from Wisconsin and Indiana)

- Monitored surface and tile water flow, P concentration and loading from a number of fields for several years
- In some fields peak flow from tile occurred at the same time or even a little before peak flow from surface runoff
- Sub-surface drainage (tile) accounted for 42 to 96 percent of the total water discharged from the fields
- Average annual tile TP ranged from 210 to 1,320 ug/l and soluble DP ranged from 170 – 890 ug/l
- Overall, tile drainage accounted for 17 to 48 percent of the TP and up to 49 percent of the DRP (soluble) lost from the fields

Watershed Level Studies

Ohio Study:

- Monitored fields and a small intensive ag watershed
- 82% of the watershed was tiled
- Tile accounted for 47% of the water discharged at the mouth of the watershed and 48% of soluble P (DRP)

Tracking Hydrologic Pathways of Phosphorus Ewing Watershed, Qc

	Fall 2008	Spring 2009
	Sept. 21– Dec. 8	Mar. 25– Jun. 21
Water yields		
Groundwater / mm (%)	28 (40)§	58 (49)§
Subsurface drains / mm (%)	34 (48)§	47 (40)§
Surface Runoff / mm (%)	8 (12)§	12 (10)§
Total / mm	70	117
Phosphorus yields		
TP groundwater / g ha^{-1} (%)	24 (9)§	13 (4)§
TP subsurface drains / g ha^{-1} (%)	82 (30)§	82 (28)§
TP surface runoff / g ha^{-1} (%)	139 (50)§	121 (41)§
TP other sources / g ha^{-1} (%)	31 (11)	77 (26)
TP total / g ha^{-}	276	293

§ Seasonal percentage

Summary of What we Know

- On a field level in some cases tile drainage can account for over 90% of the water leaving a field (reduced tillage)
- On a field and watershed level tile drainage can contribute as much phosphorus as does surface runoff.
- Tile drainage changes the dominant water flow pathway from a surface pathway to a subsurface flow pathway
  - Most of current practices are focused on reducing sediment and phosphorus in surface water
  - Currently we have no implemented practices in Vermont that are focused on reducing P in tile lines
- Thus a significant portion of the P load from ag fields with tile is being ignored
- In addition, most of the P in tile discharge is in a soluble form, hence it is very bioavailable

What We Don't Know

- The extent of tile drainage in various Vermont watersheds – Jewett Brook Watershed
- Don't know range and averages for tile drainage concentrations and loading rates in Vermont
- Don't know how tile drainage P concentration relates to soil type, cropping system, nutrient and manure management, soil P levels, etc. in Vermont
- Don't know how to effectively control P in tile drainage systems in Vermont

What We Need

- Need information on the extent of tile drainage in each watershed (spring CIR?)
- Need more accurate quantitative data on P loading from tile drainage in LCB watersheds (inc. concentration data)
- Need to include tile drainage loading estimates as part of the TMDL goals (maybe have it as a subset of the crop field loading)
- Need to include tile drainage as part of routine farm resource assessments
- May need new assessment tools such as NC's PLAT
- Need to test and implement a suite of conservation practices to reduce P loading from tile drainage, including:

  Nutrient management
  Phosphorus removal systems
  Constructed wetlands
  Soil amendments, including WTR's?
  Drainage water management

Field and Nutrient Management to Minimize P in Tile Drainage

- Minimize nutrient and manure inputs
- Adjust timing of applications to avoid very dry or wet conditions
- At least minimal tillage to break up macropore connectivity
- Avoid applications directly over tile lines and around surface inlets if possible

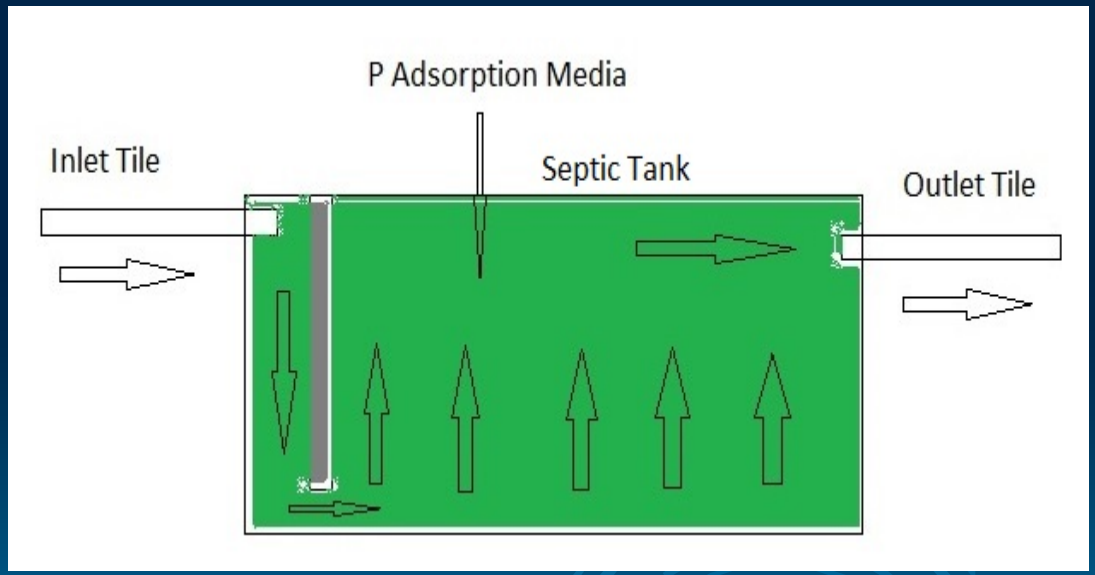
Structural Practices: Phosphorus Removal Systems

- New Vermont NRCS interim practice
- Can include both subsurface (tile) and surface P removal systems
- Can be relatively easy to installed “in-line” with existing and new tile systems in most situations
- First project will start this summer to install and evaluate two systems for tile drainage

Example P Removal Systems

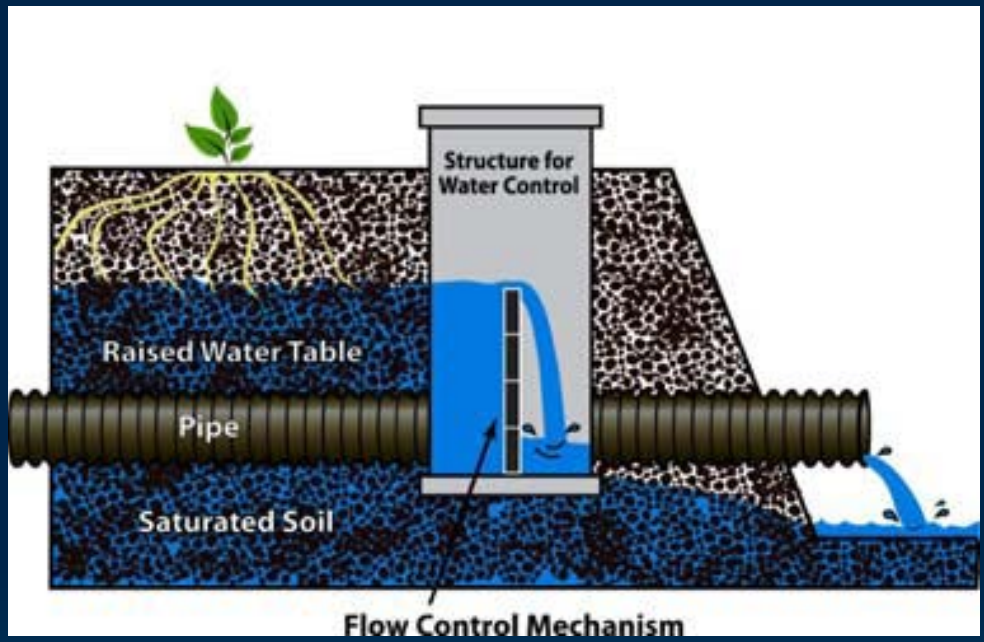
Oklahoma Surface Phosphorus Removal System

Diagram of Tile Phosphorus Removal System



Structural Practices: Drainage Water Management

- Use a water control structure to raise and lower water table
- Raise the water table in winter to “hold” water in the soil
- Has been shown to be very effective for N
- Possibility it could increase P concentrations



Handheld Phosphate Test Meter

Note: Instrument measures Elemental P


Questions?