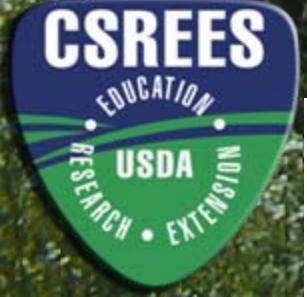
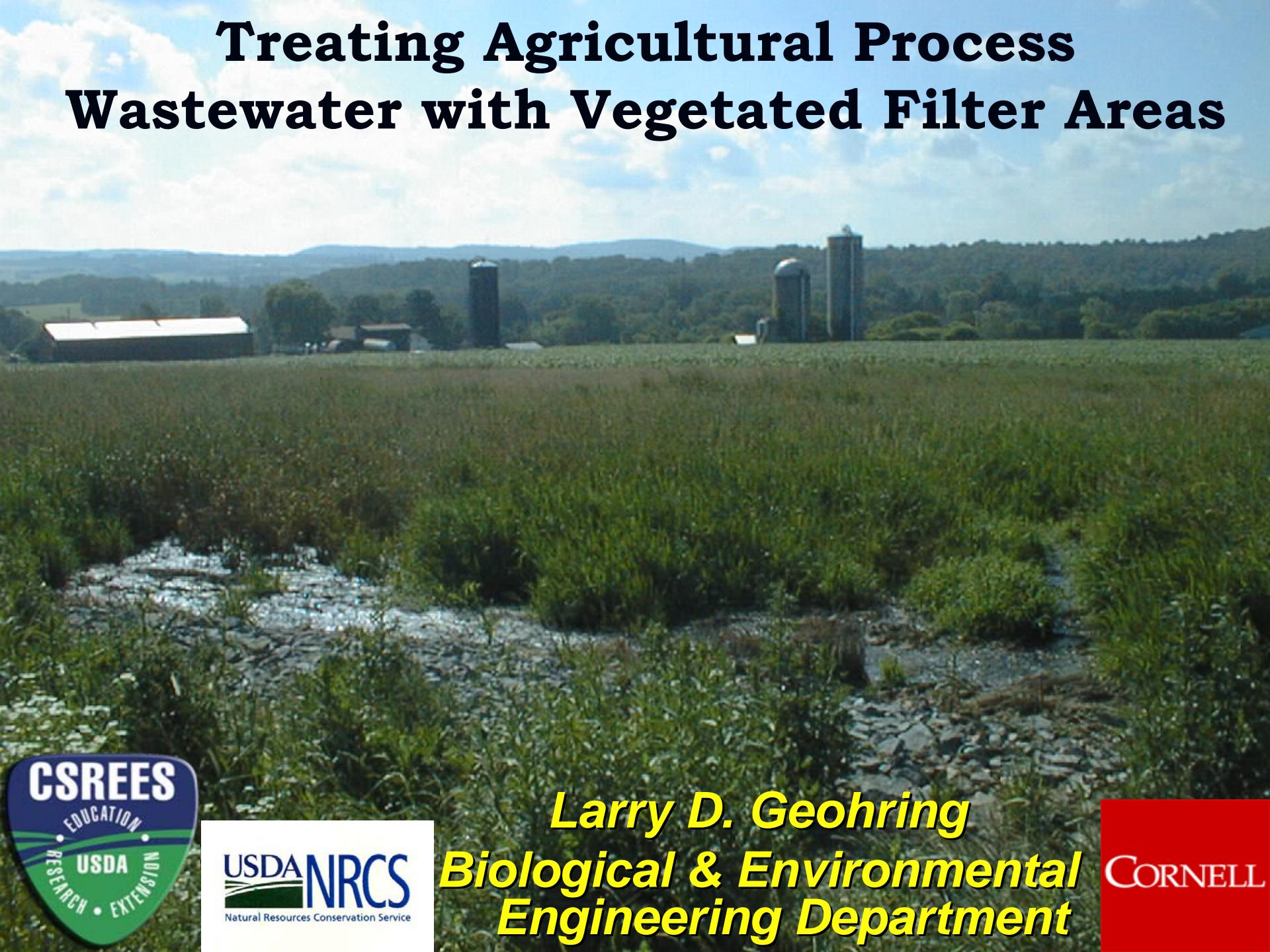


# Treating Agricultural Process Wastewater with Vegetated Filter Areas



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**Biological & Environmental  
Engineering Department**

CORNELL

# Presentation Focus:

① Effluent  
Distribution  
Methods



② Current  
Research  
Monitoring



③ Limiting  
Site Factors  
and Effects

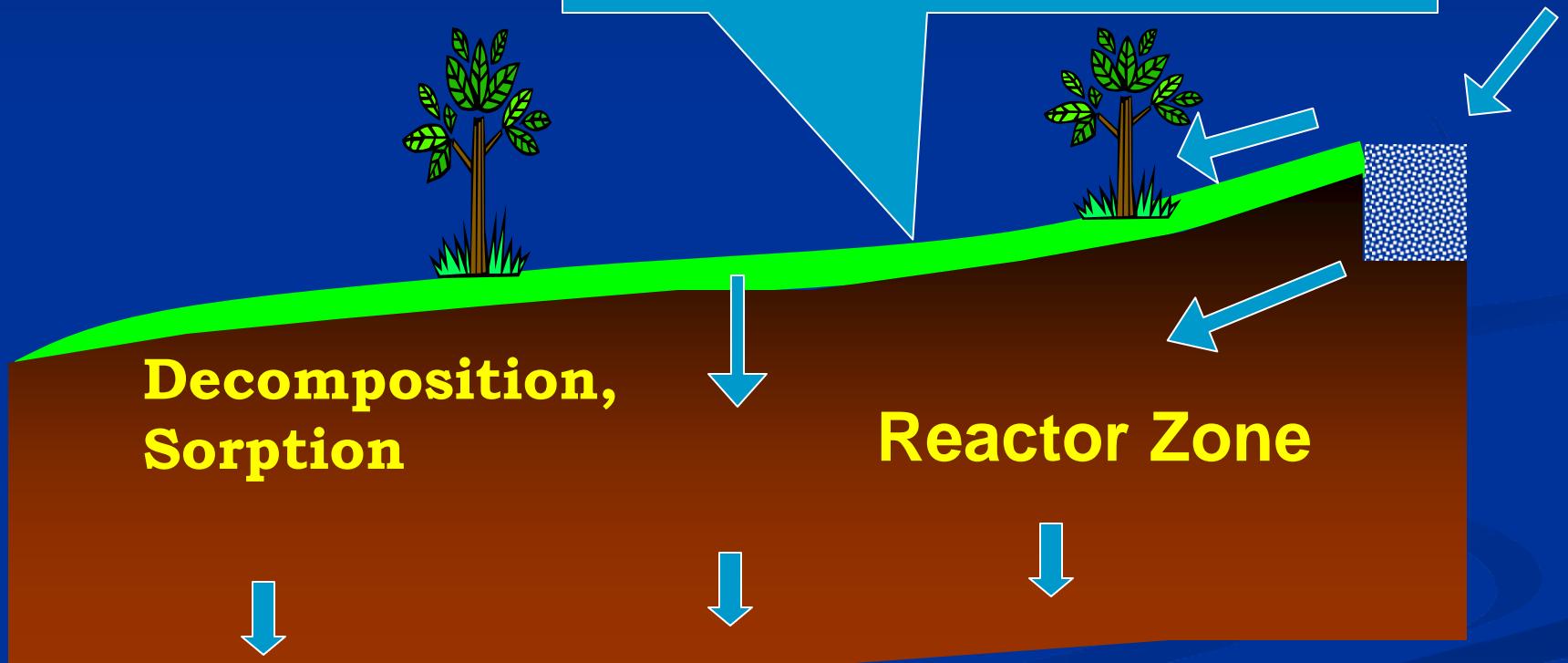


**Joshua Faulkner  
Wei Zhang**

# Effluent Distribution Methods

## VFA Diagram

Surface Processes:  
Filtration, Deposition,  
Infiltration, Volatilization



Groundwater Impact ??

## **Gravel Trench (No spreader board)**

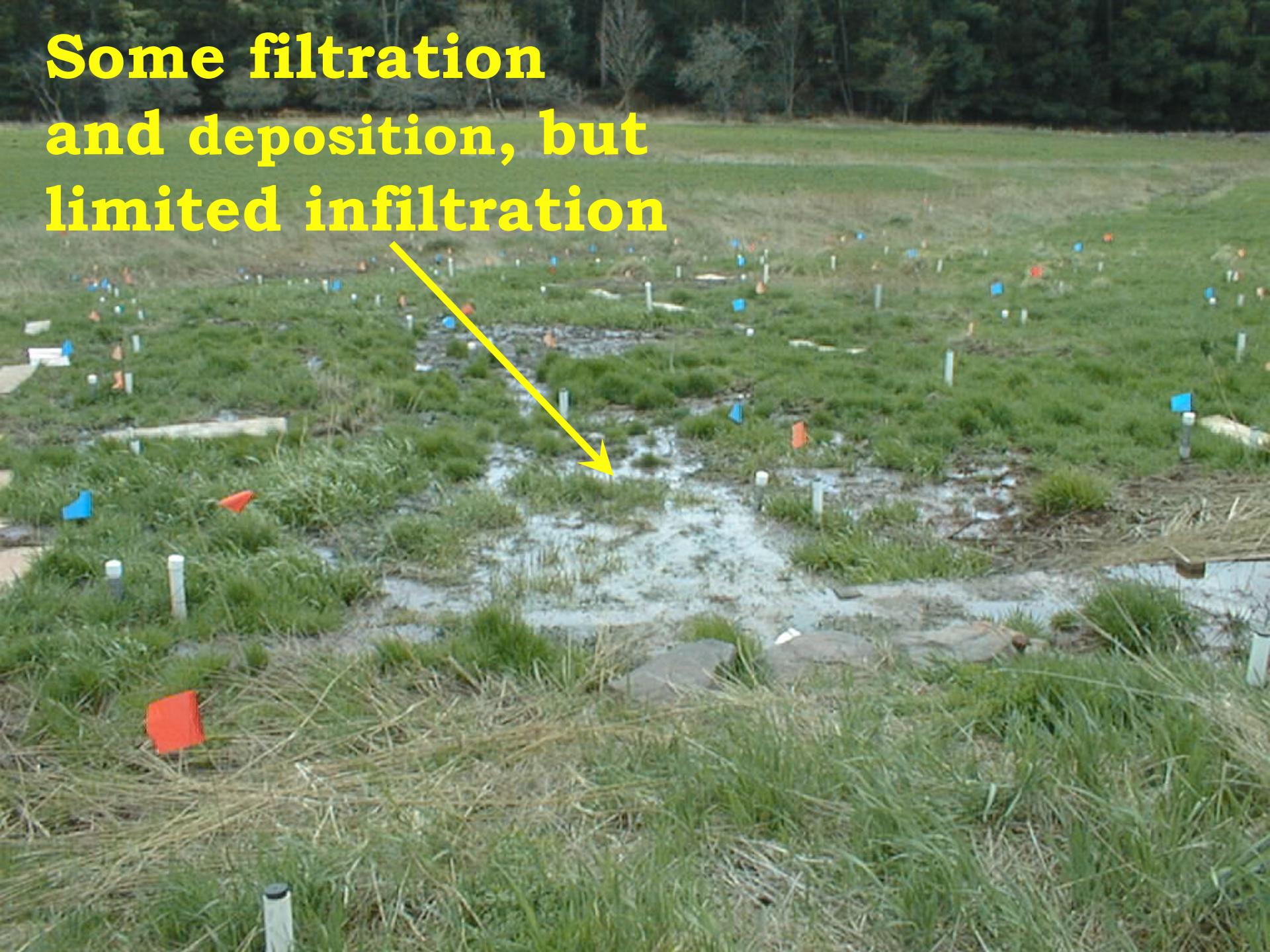


**Limited filtration,  
deposition or  
infiltration processes**

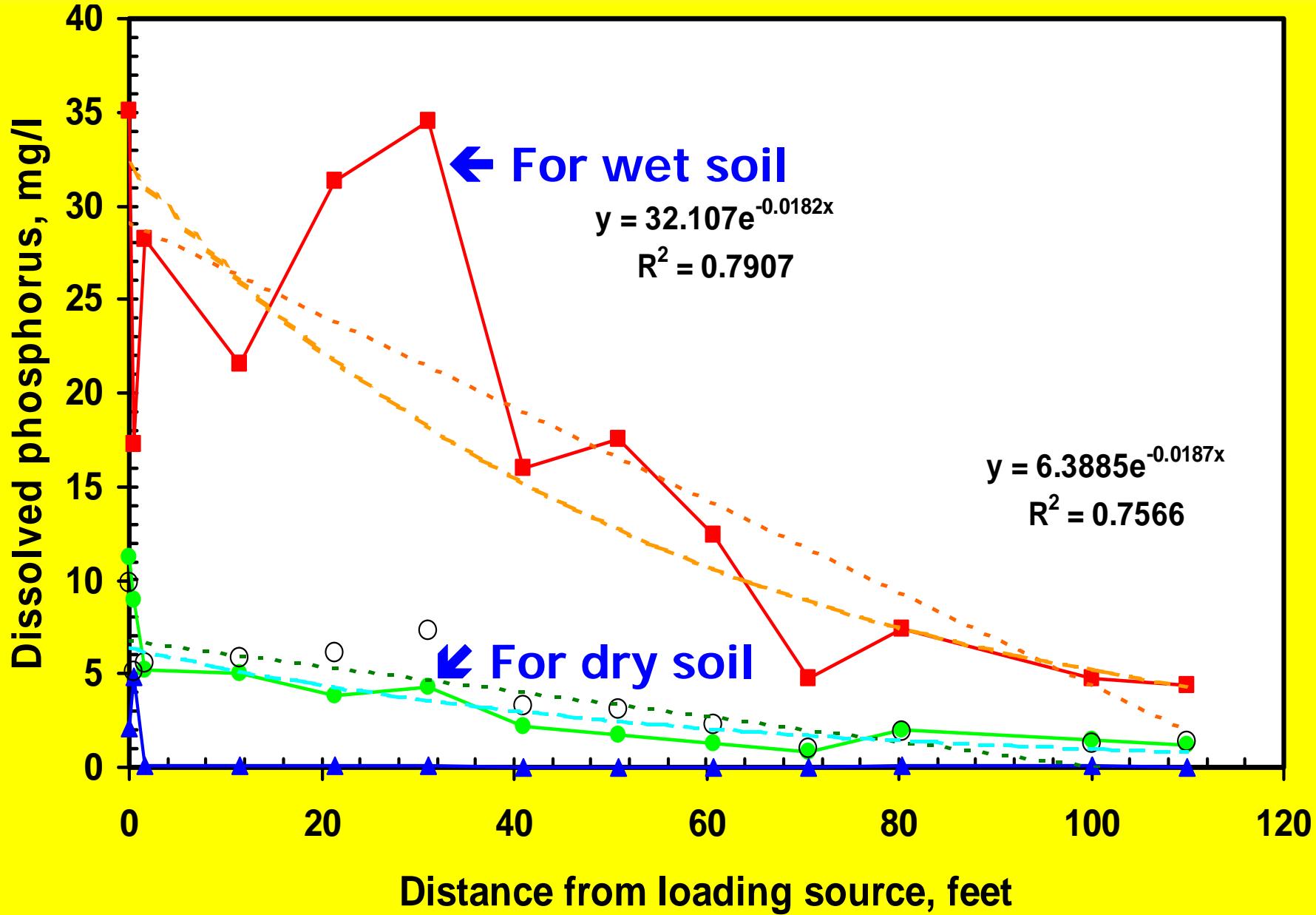
**Gravel trench with level-lip spreader  
and single discharge point**



**Some filtration  
and deposition, but  
limited infiltration**

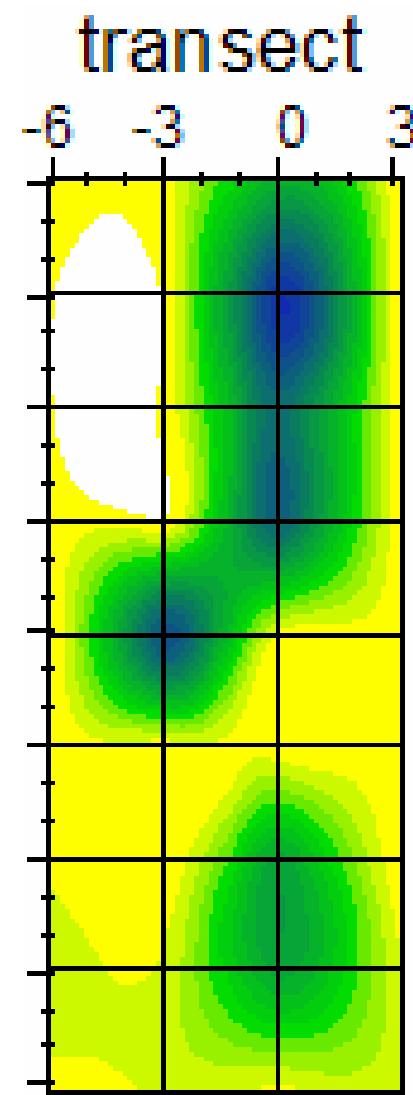
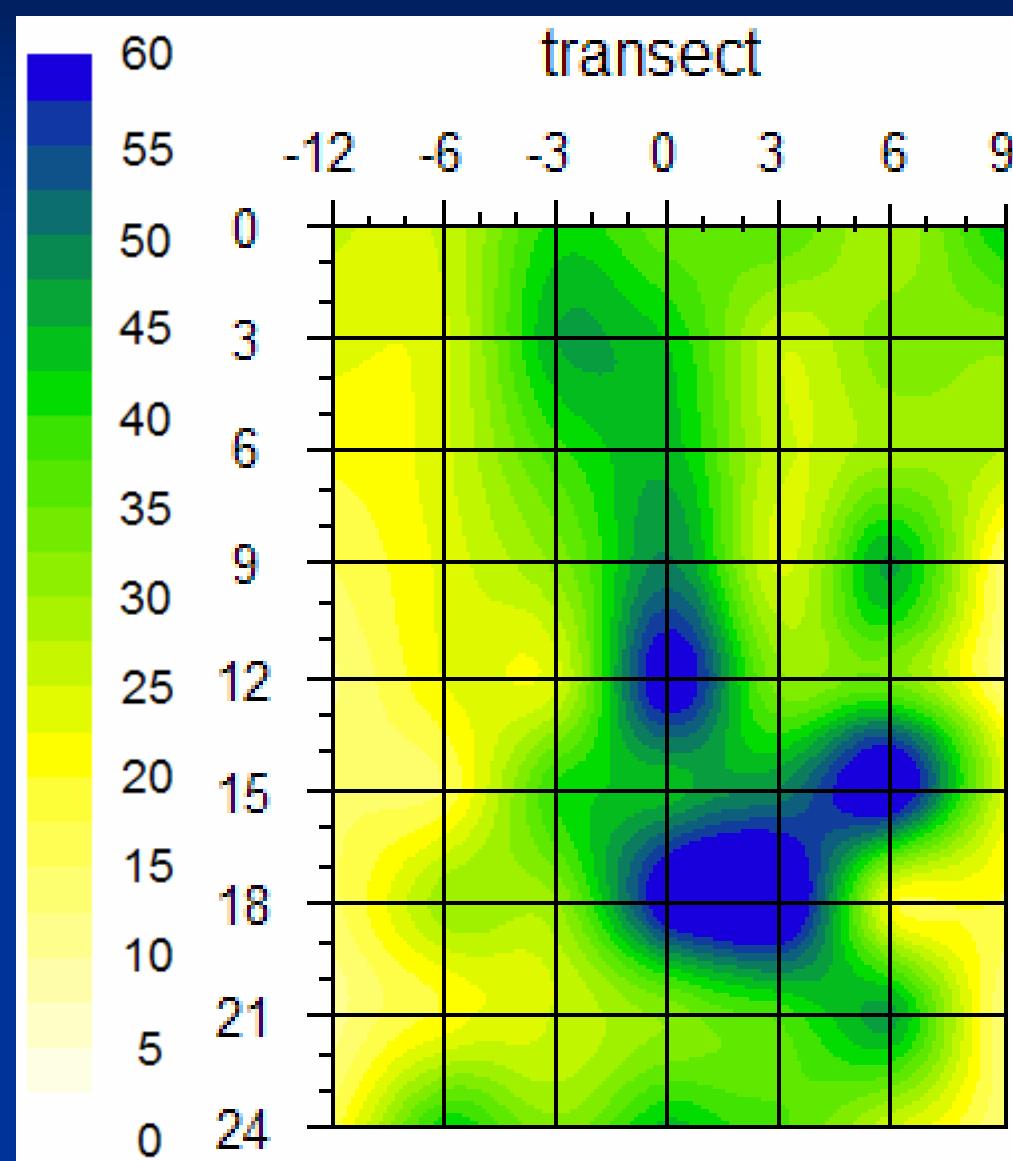


# VFA results for removing P from milkhouse



# Morgan's Soil Test P

# Soil-Water P



P concentration



← 2 Discharge pipes →

*Gravel trench and spreader  
board – 2 discharge points.*

*Effluent went  
around edge  
of VFA*



0.57  
0.00

0.59  
0.00

0.58  
0.00

0.55  
0.00

0.56  
0.00

0.57  
0.00

0.58  
0.00

0.59  
0.00

0.60  
0.00

0.61  
0.00

0.62  
0.00

0.63  
0.00

0.64  
0.00

0.65  
0.00

0.66  
0.00

0.67  
0.00

0.68  
0.00

0.69  
0.00

0.70  
0.00

0.71  
0.00

0.72  
0.00

0.73  
0.00

0.74  
0.00

0.75  
0.00

0.76  
0.00

0.77  
0.00

0.78  
0.00

0.79  
0.00

0.80  
0.00

0.81  
0.00

0.82  
0.00

0.83  
0.00

0.84  
0.00

0.85  
0.00

0.86  
0.00

0.87  
0.00

0.88  
0.00

0.89  
0.00

0.90  
0.00

0.91  
0.00

0.92  
0.00

0.93  
0.00

0.94  
0.00

0.95  
0.00

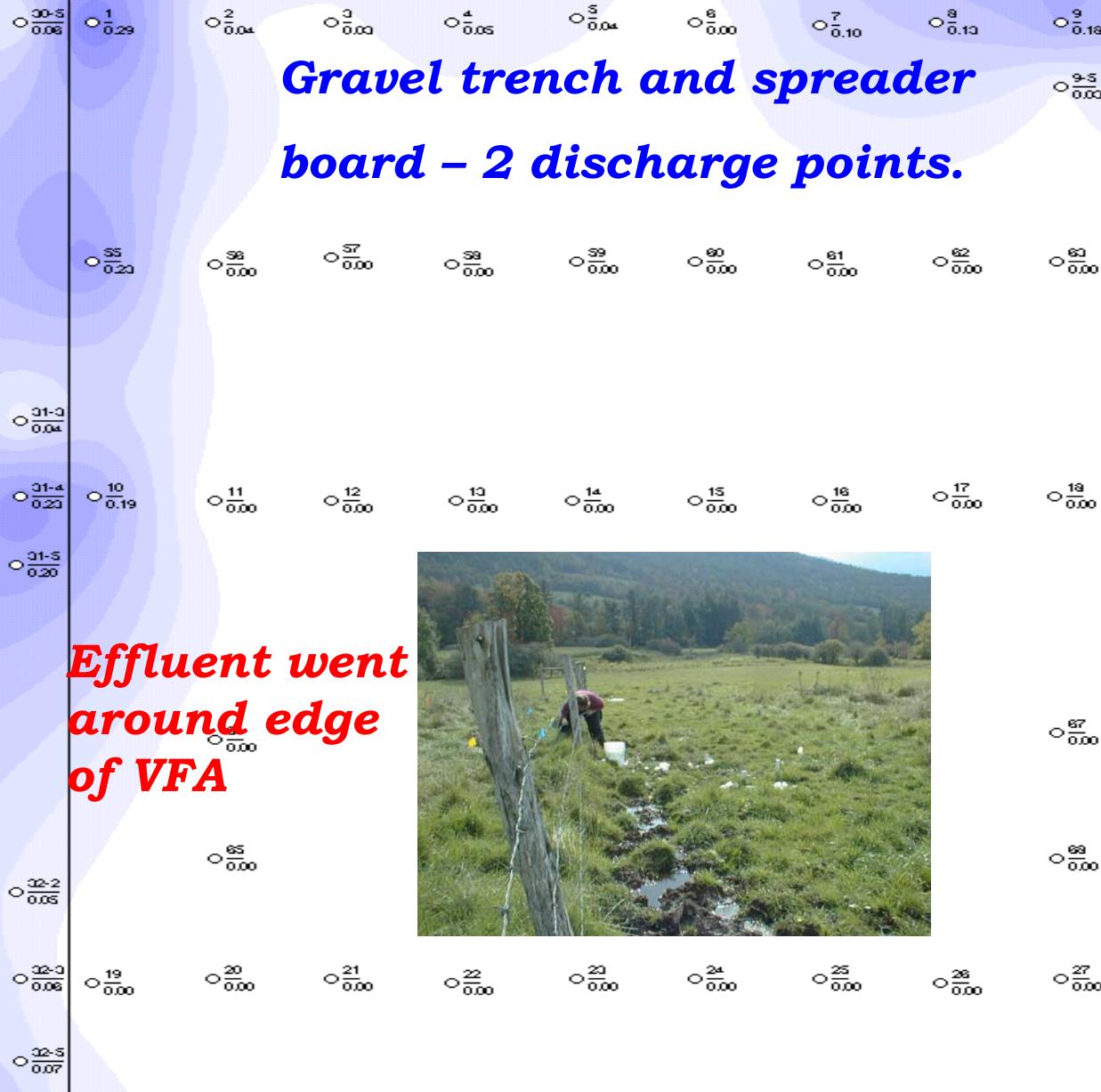
0.96  
0.00

0.97  
0.00

0.98  
0.00

0.99  
0.00

0.00  
0.00



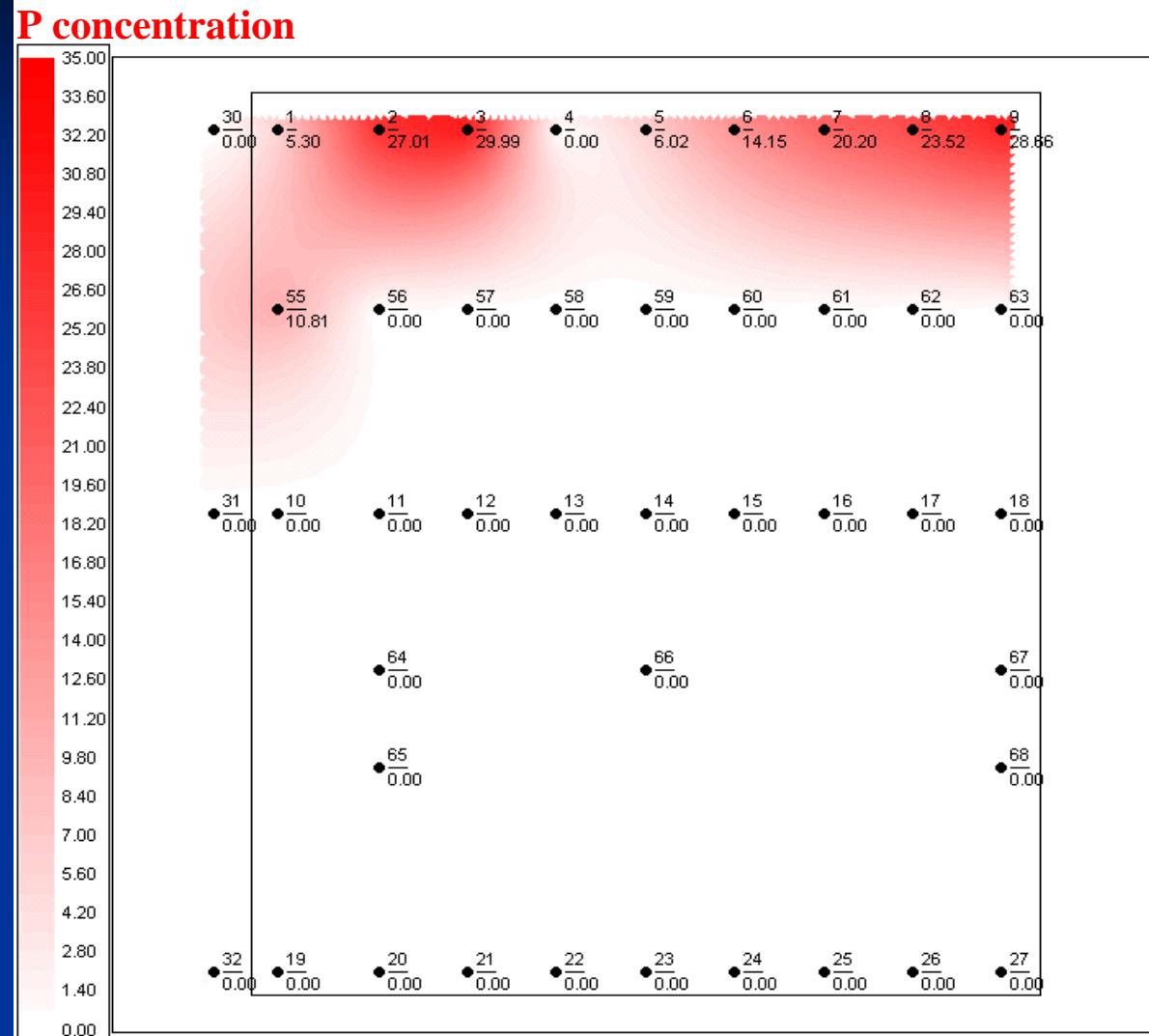
**Maintenance to  
plug ends of  
gravel trench &  
spreader board**



**2 discharge pipes  
converted to more  
even distribution  
method.**

# Vegetated filter area study

The more uniform distribution improved infiltration, and enhanced the wastewater-to-soil contact. This helps with dissolved P removal.

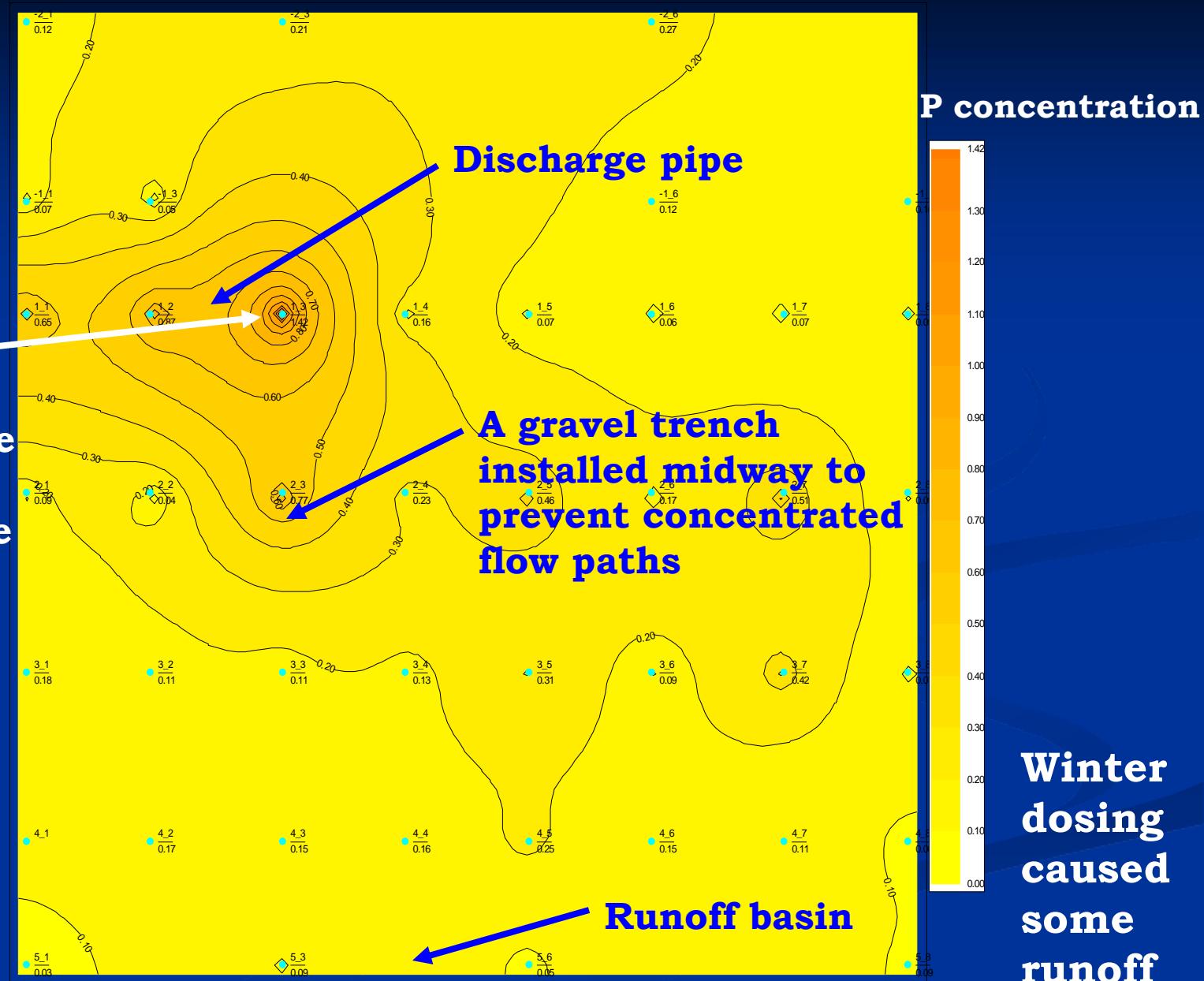


# Above Ground 'Distributed Dosing' to Gravel Trench



# Average P Iso-concentration Graph

Highest concentration here, likely due to low spot on suspended pipe



**Concrete Pad  
Spreader with  
Rock edge**

**Tompkins County System**

**Concentrated  
flow paths still  
developing and  
persisting  
through VFA**





## Silage Bunker Runoff into VFA

$\text{NH}_4\text{-N}$  - 69 mg/L  
 $\text{NO}_3\text{-N}$  - 3.9 mg/L  
SRP - 37 mg/L  
TP - 41 mg/L  
TOC - 1180 mg/L

$\text{NH}_4\text{-N}$  - 22 mg/L (68%)  
 $\text{NO}_3\text{-N}$  - 0.3 mg/L (92%)  
SRP – 6.9 mg/L (81%)  
TP – 7.2 mg/L (82%)  
TOC - 121 mg/L (90%)



Surface runoff  
break through

**Split Cell VFA  
to enhance  
distribution**

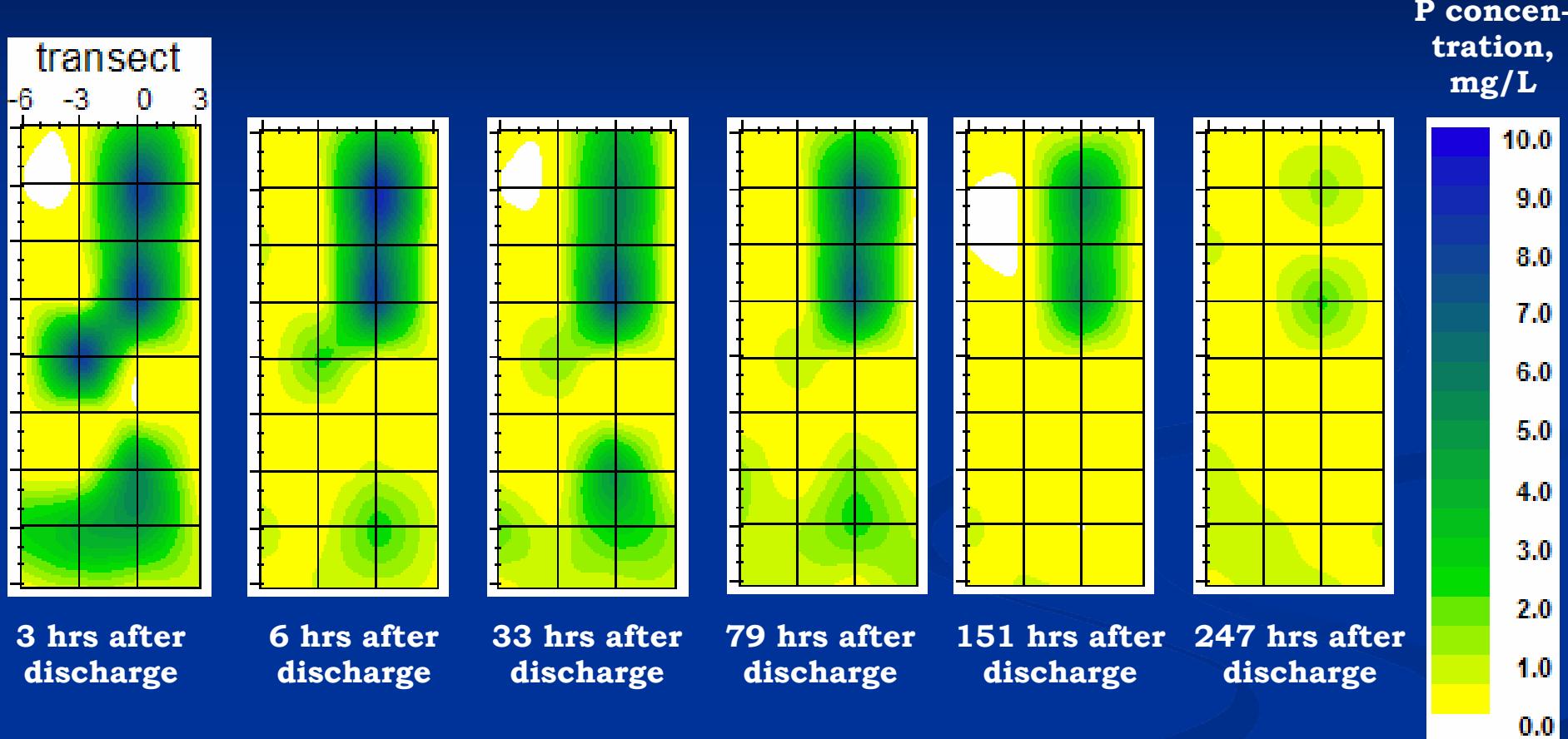


# Dosing (Flout) System to alternate areas of the VFA



**Delaware County System**

# SRP concentration in monitoring wells after dosing (Milkhouse wastewater)



# Distributed Dosing Concept

## Advantages:

- ① Spreads effluent over wider area
- ② Dosing allows time for infiltration-adsorption
- ③ If pumped, could go to most suitable soil area



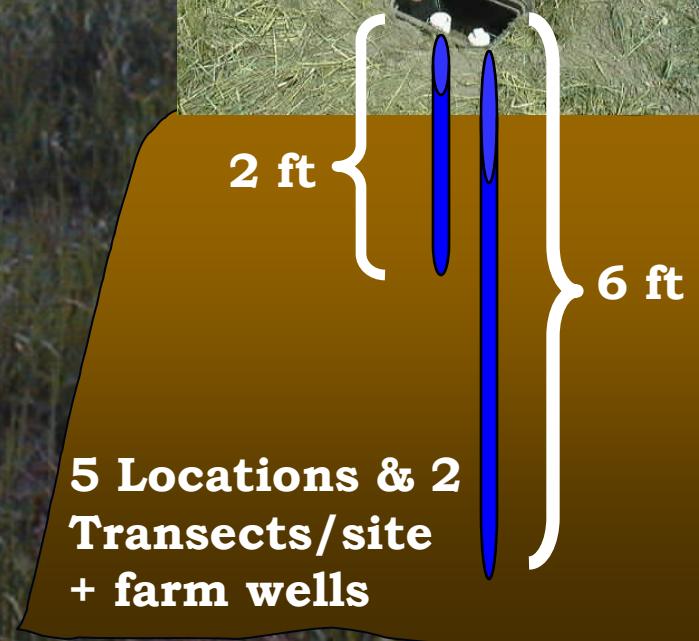
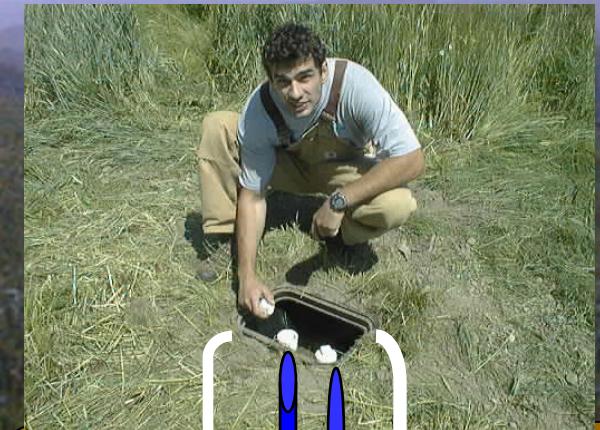
## Disadvantages:

- Requires more storage, hardware, and energy (if pumped)
- Higher initial and M & O costs

# Current Research Monitoring



# What's percolating down into the VFA?

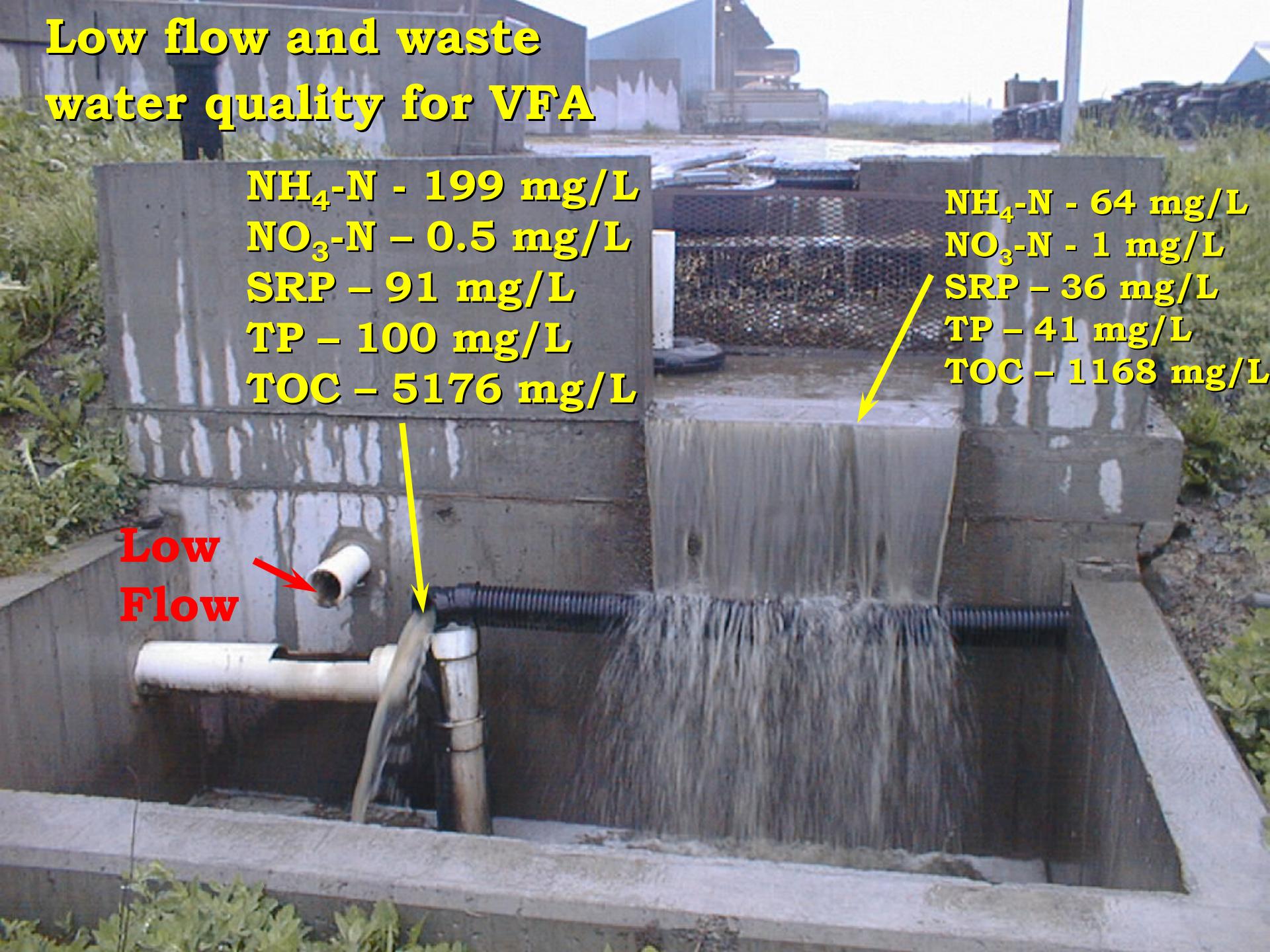


# Low flow and waste water quality for VFA

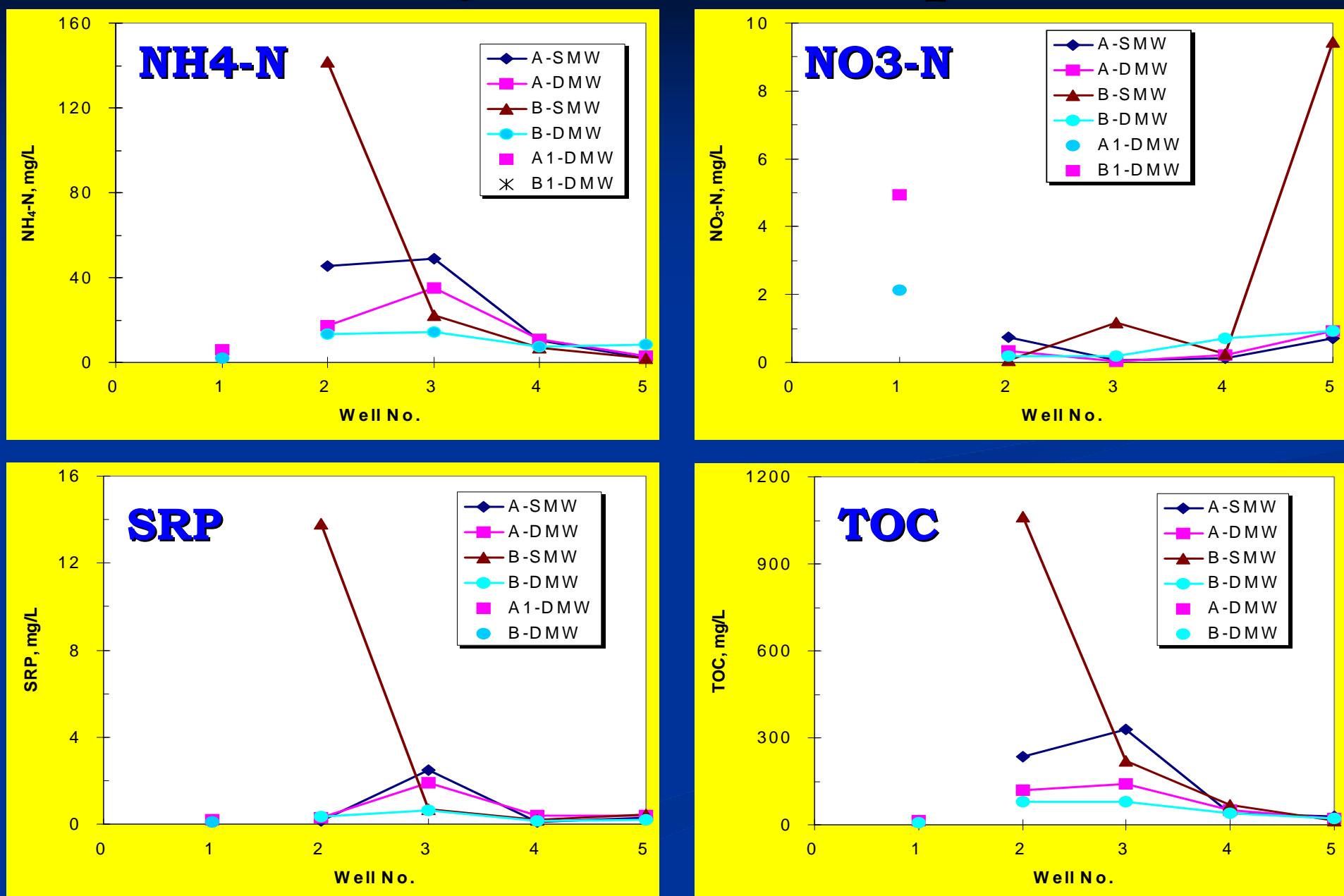
NH<sub>4</sub>-N - 199 mg/L  
NO<sub>3</sub>-N - 0.5 mg/L  
SRP - 91 mg/L  
TP - 100 mg/L  
TOC - 5176 mg/L

Low Flow

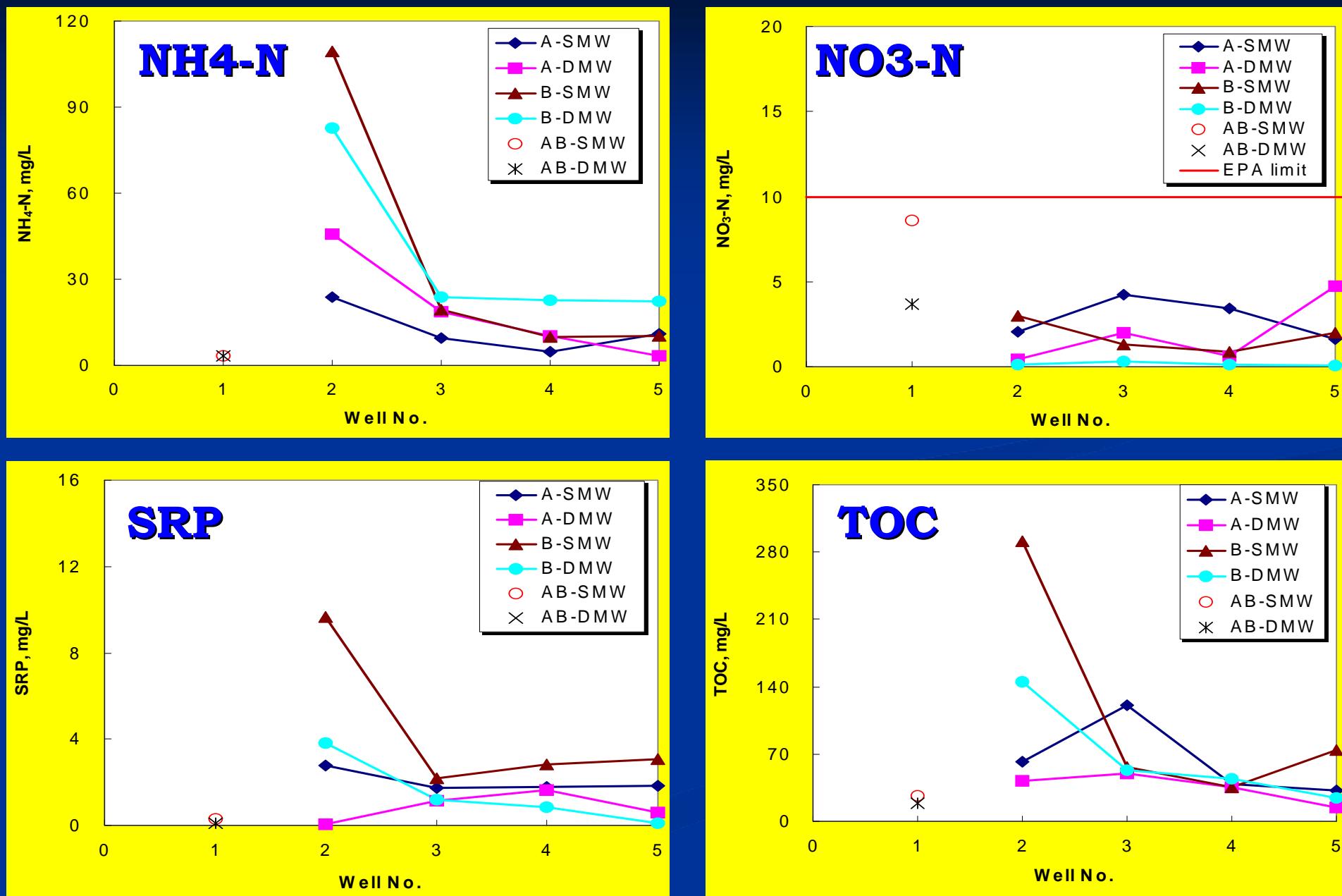
NH<sub>4</sub>-N - 64 mg/L  
NO<sub>3</sub>-N - 1 mg/L  
SRP - 36 mg/L  
TP - 41 mg/L  
TOC - 1168 mg/L



# Preliminary Results-Tompkins Site

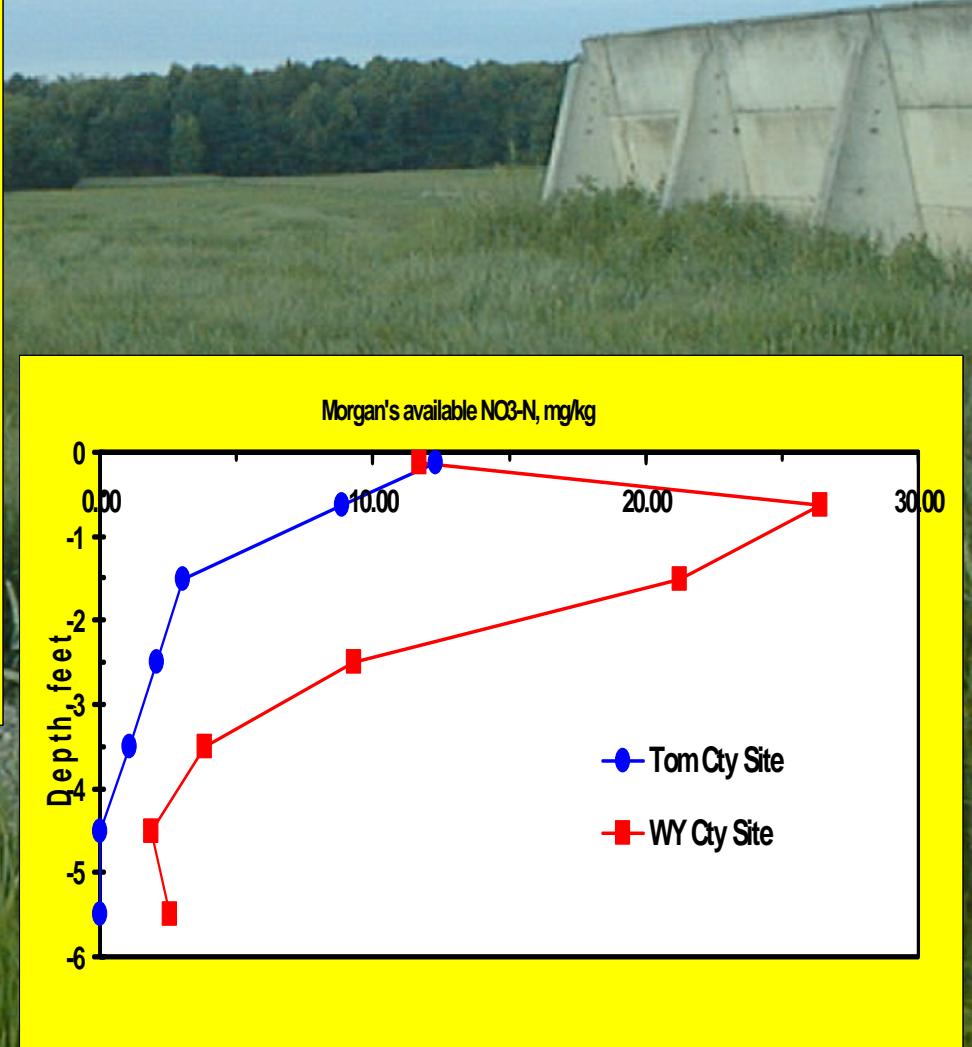
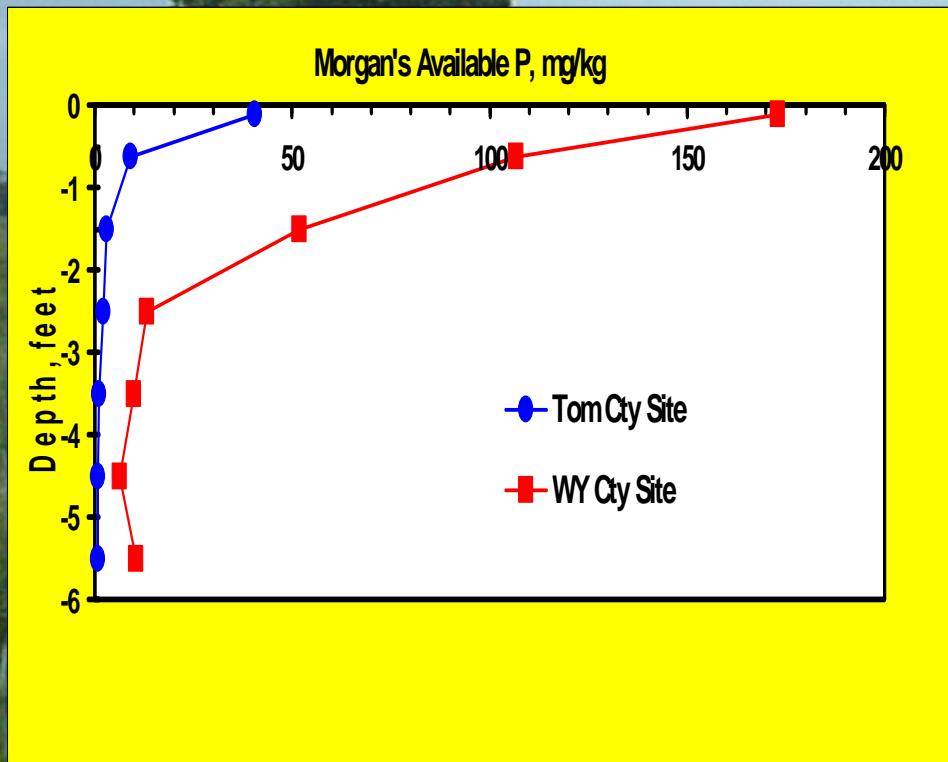


# Preliminary Results-Wyoming Site



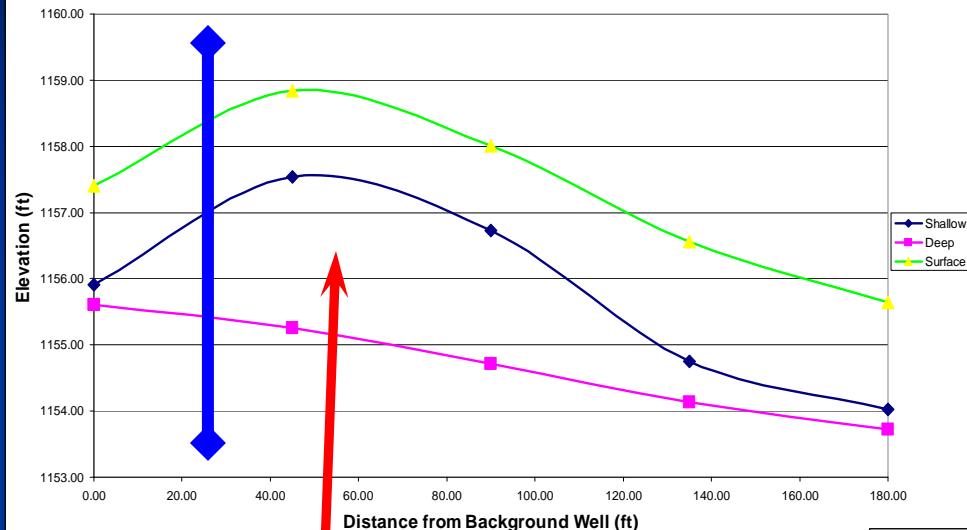
# Limiting Site Factors and Effects

## How does location impact VFA performance?



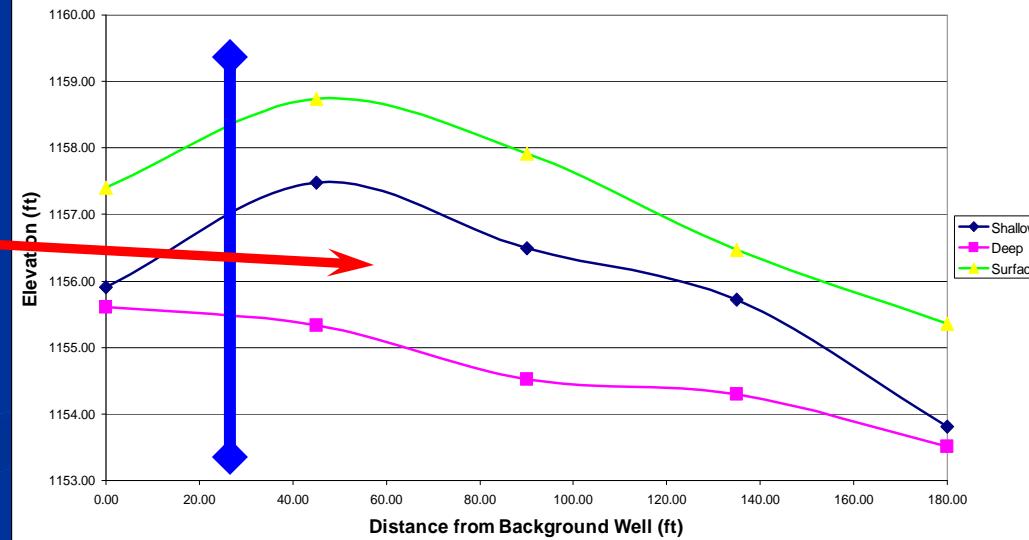
# Wyoming Site Piezometer Data

A-transect Average Piezometer Water Elevations

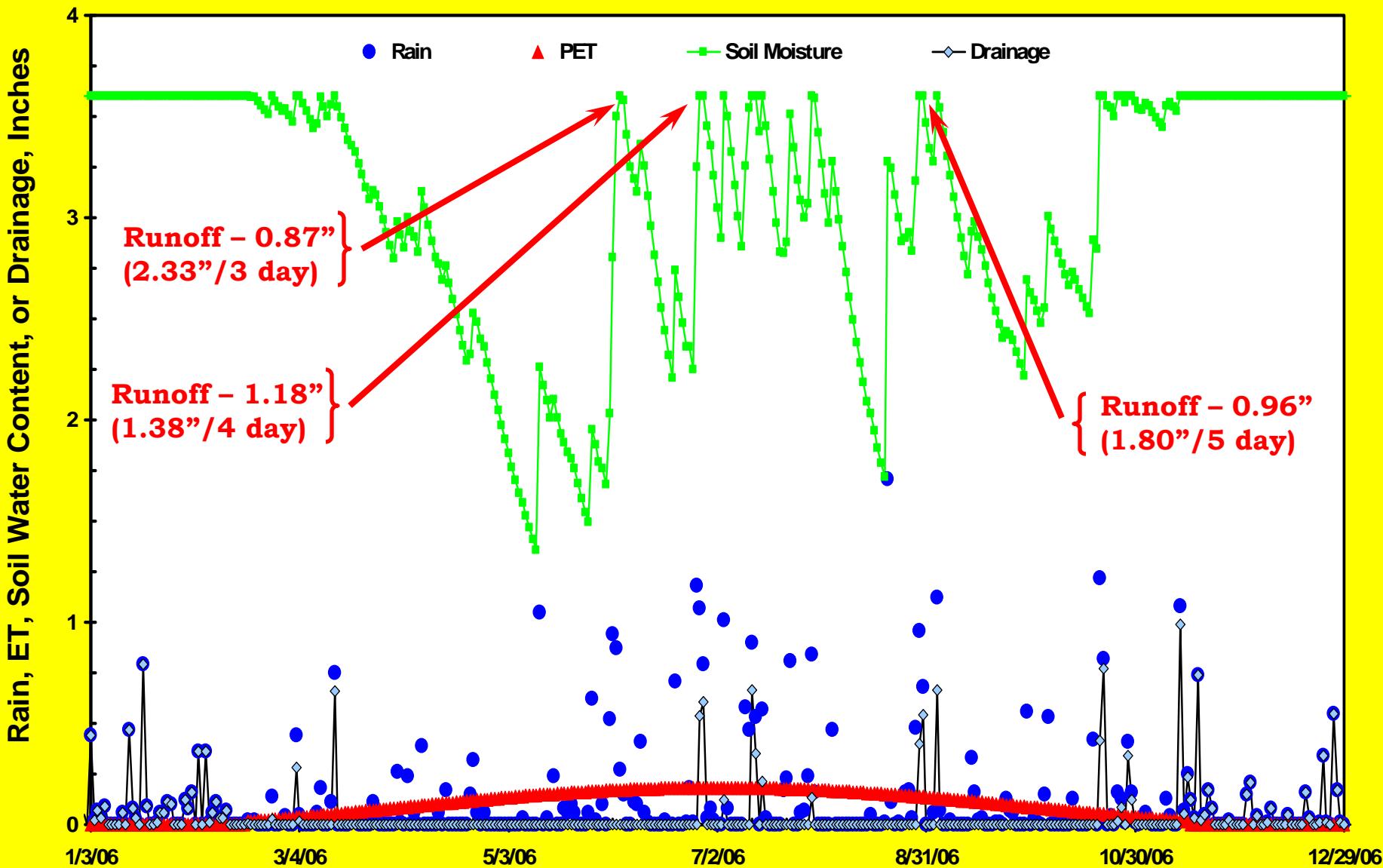


Water  
mounding  
effect

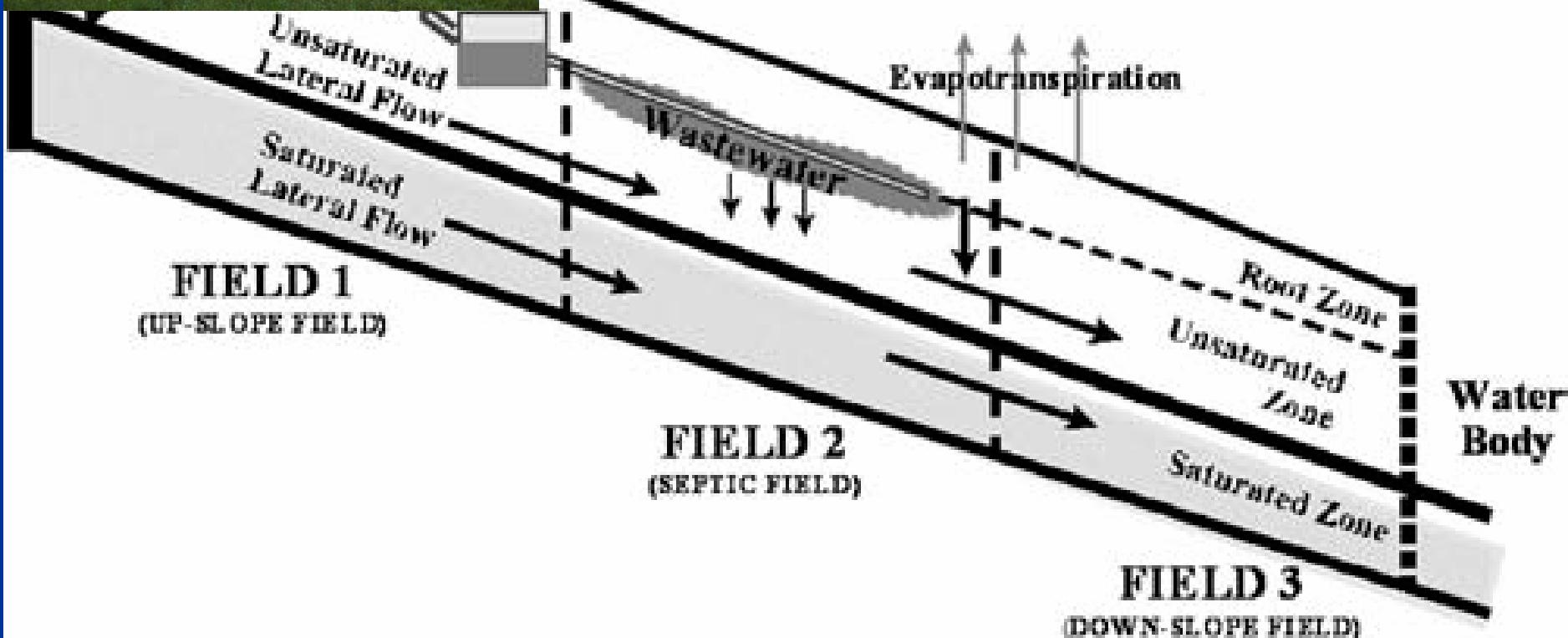
B-transect Average Piezometer Water Elevations



# Tompkins Site – Modeling Hydrology



# Location Effects





**M & O Aspects**



### Some Conclusions:

- 1) Wastewater distribution is important to VFA effectiveness**
- 2) VFA reduces risk of contaminated surface water discharge from livestock facilities**
- 3) No Discharge Rules still may be difficult to comply with in a cool, humid climate**
- 4) Overall bio-geochemical dynamics and considerations are still poorly understood**