Integrated In-field, Edge-of-field, and In-stream Conservation Management for Improving Watershed Conditions and Water Quality

5-9 February, 2006

2006 National Water Conference

Jeff Strock

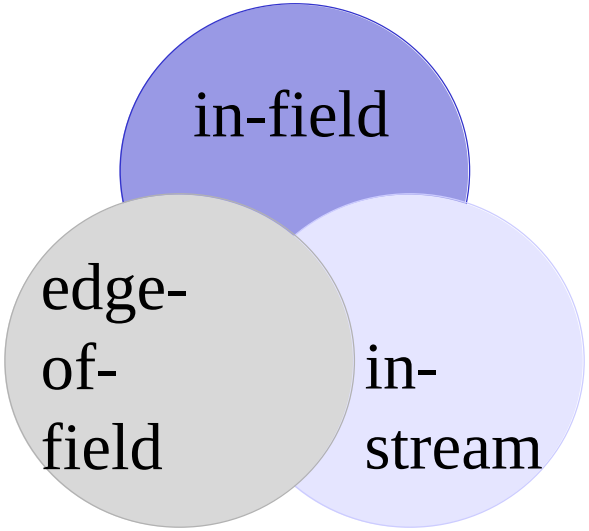
Soil Scientist

University of Minnesota – Southwest Research and Outreach Center, Lamberton, MN

Goals

- *Define*, *characterize*, and *manipulate* the field and watershed scale *processes and relationships* that affect nutrient status within, fields, wetlands, and ditches that receive agricultural runoff water.

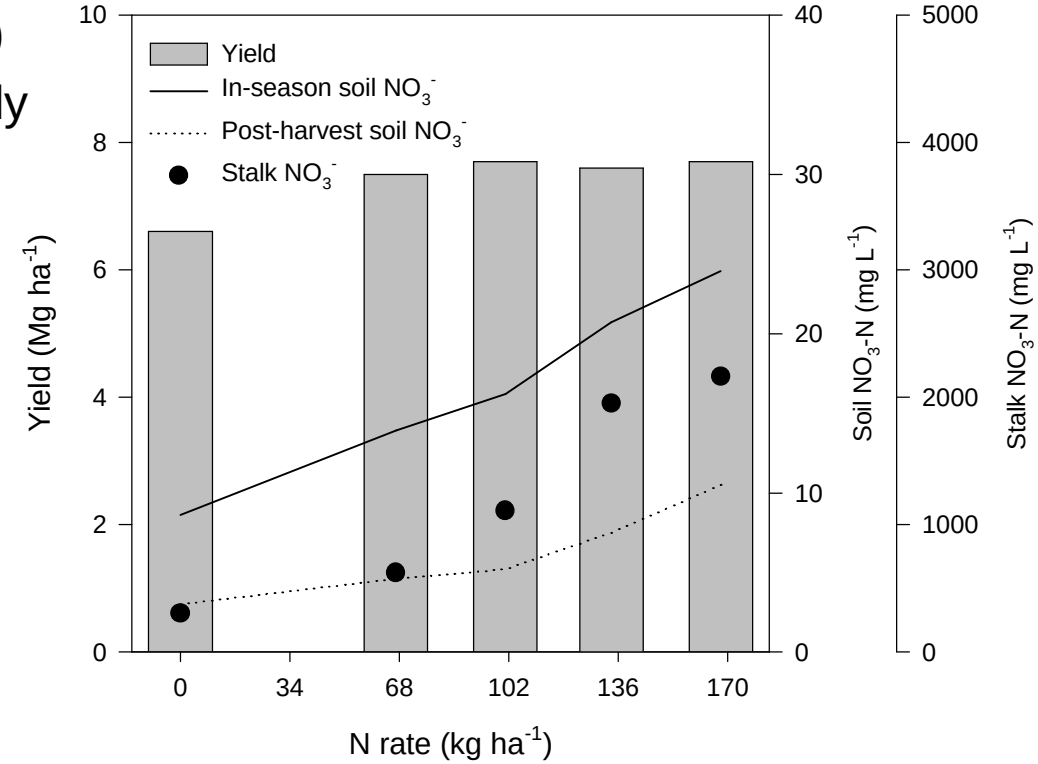
Holistic Approach



IN-FIELD

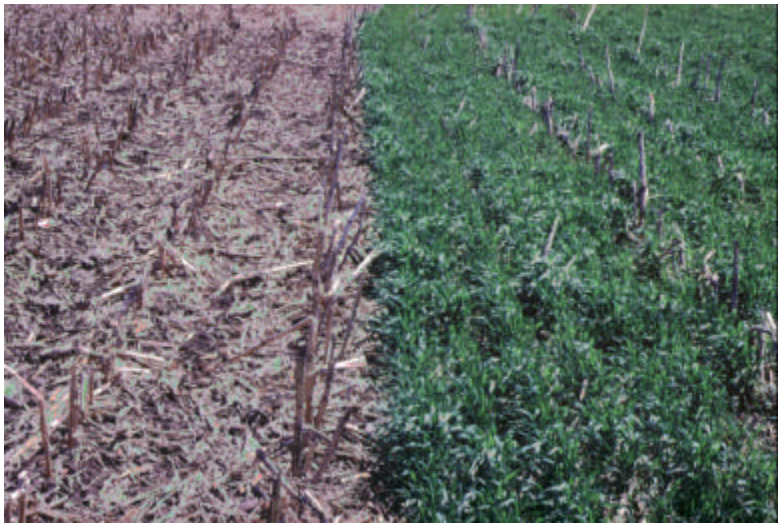
In-field: Nitrogen management

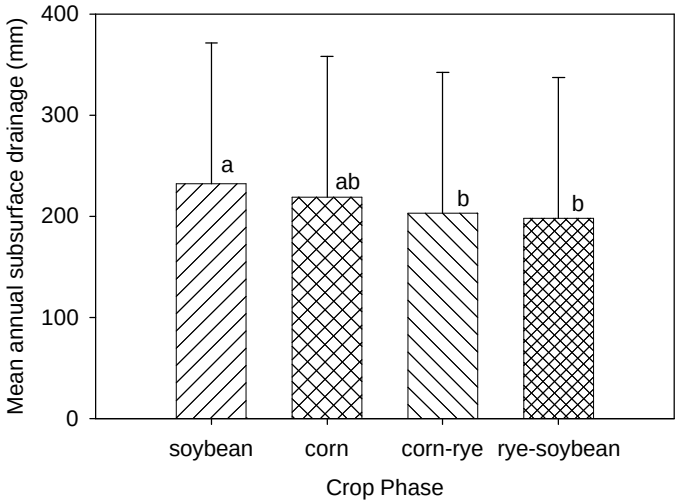
- <u>Treatments included:</u>
  - Five fertilizer N rates (0, 67, 100, 134, and 168 kg N ha^{-1})
  - Three Application times (early fall, late fall, and spring)
  - Two N sources (anhydrous ammonia and urea)

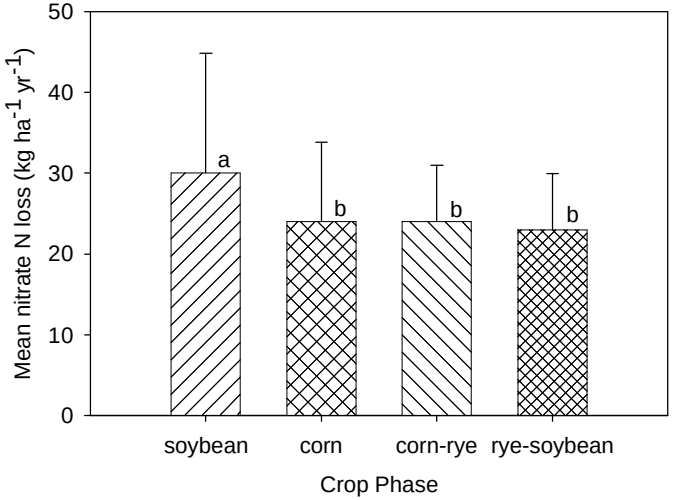


In-field: Cover cropping

- Rye drilled into corn stalks (181 kg/ha)
- Spring fertilizer N (134 kg N/ha)
- Nitrate loss
- Grain Yield





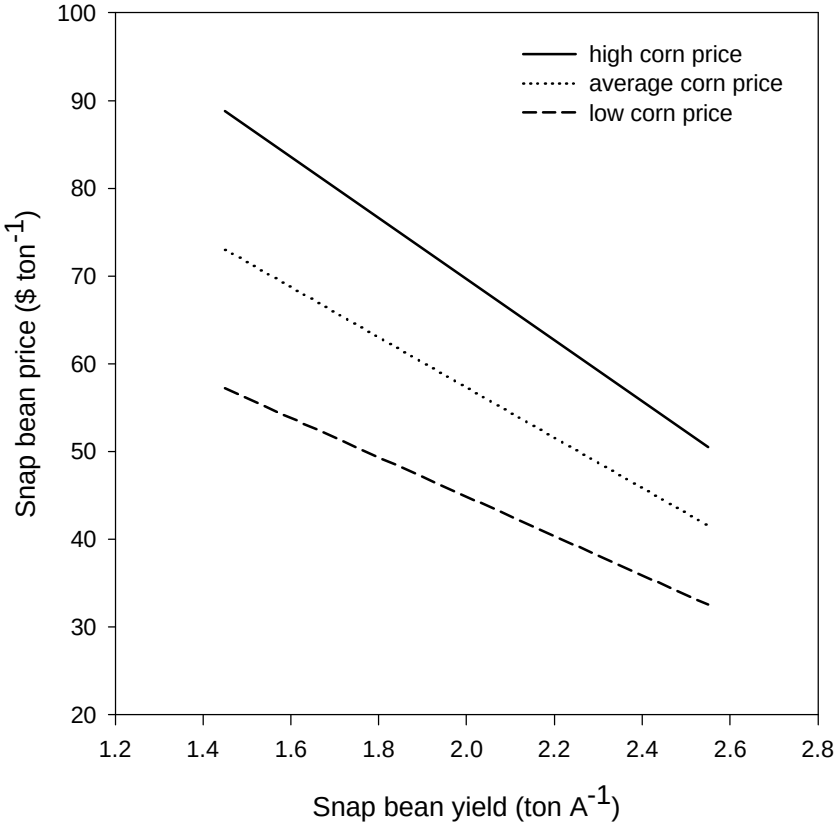


In-field: Crop diversification

Table. Annual nitrate-nitrogen loss and mean crop yield from 2003-2005.

	Yield		NO_3^--N
	kg ha^{-1}		kg ha^{-1}
Winter wheat-***Snap bean***	2602 (48)	***4234 (1.9)***	15
Barley-***Snap bean***	3508 (65)	***5210 (2.3)***	20
Soybean	3502 (52)		21

Values in parenthesis are yield values for soybean and small grain in bu A^{-1} and snapbean in ton A^{-1}.



In-field: Crop diversification

CSREES Project No. 2001-51130-11435

- Two adjacent fields totaling 65 hectares each
  - ~49 hectares of the Elwell Agroecology Farm is organically managed

Alternative

Buckwheat

Flax/ Clover

Rye

Hairy Vetch

Conventional

Corn

Soybean

In-field: Crop diversification

CSREES Project No. 2001-51130-11435 Source: Kari Rolf, M.S. Thesis

Table. Mean annual drainage, NO_3-N, DRP, and TP loss from subsurface drainage from 2002-2004.

	Water Quality Parameter			
Management Practice	Drainage	NO_3-N	DRP	TP
	cm	kg ha^{-1}		
Alternative	6.9	5.8	0.03	0.04
Conventional	11.6	21.9	0.06	0.08

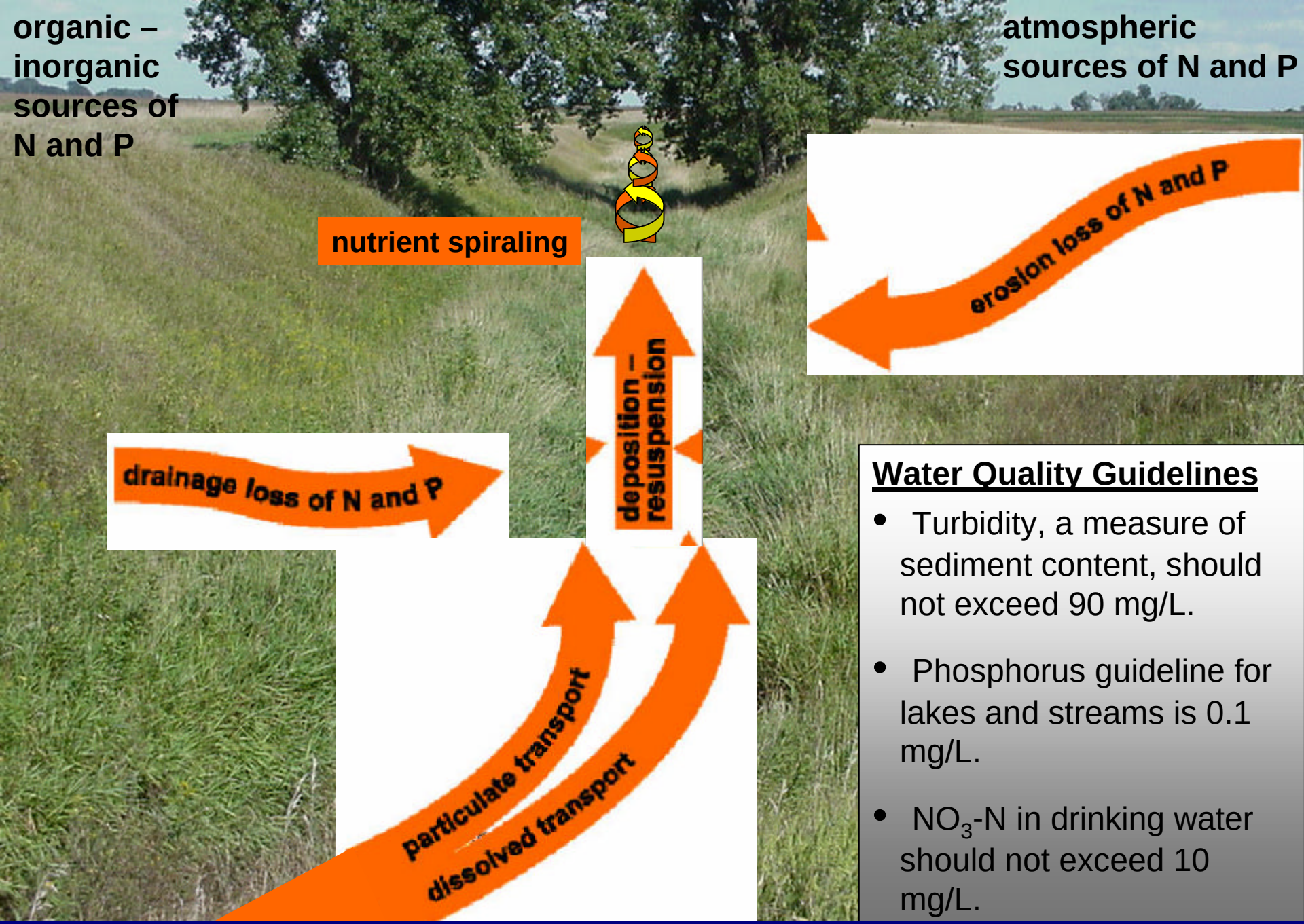
* Significance at the 0.05 probability level

** Significance at the 0.01 probability level

Table. Median values for selected soil properties from different soil horizons for alternative (AL) and conventional (CN) management practices.

	Soil Property							
Horizon	Bulk density		Saturated conductivity		Campbell *b* value		Campbell air entry value	
	AL	CN	AL	CN	AL	CN	AL	CN
	Mg m^{-3}		cm d^{-1}				kPa	
A	1.39**	1.43**	45.5**	18.1**	7.85**	9.98**	1.10*	0.79*
B	1.44**	1.48**	123.7	166.5	7.17**	8.73**	0.95	0.76
C	1.50**	1.57**	57.2	71.9	7.40**	9.24**	1.78**	0.65**

IN-STREAM



Water Quality Guidelines

- Turbidity, a measure of sediment content, should not exceed 90 mg/L.
- Phosphorus guideline for lakes and streams is 0.1 mg/L.
- NO_3-N in drinking water should not exceed 10 mg/L.

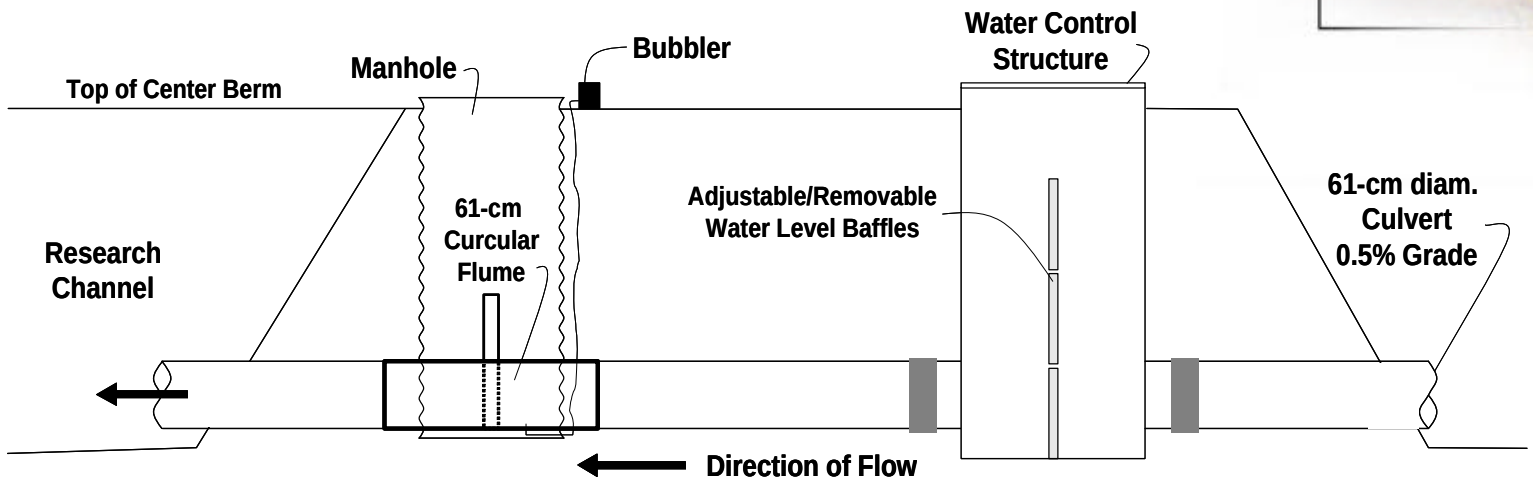
Inputs, outputs, and processes of transport of nitrogen and phosphorus

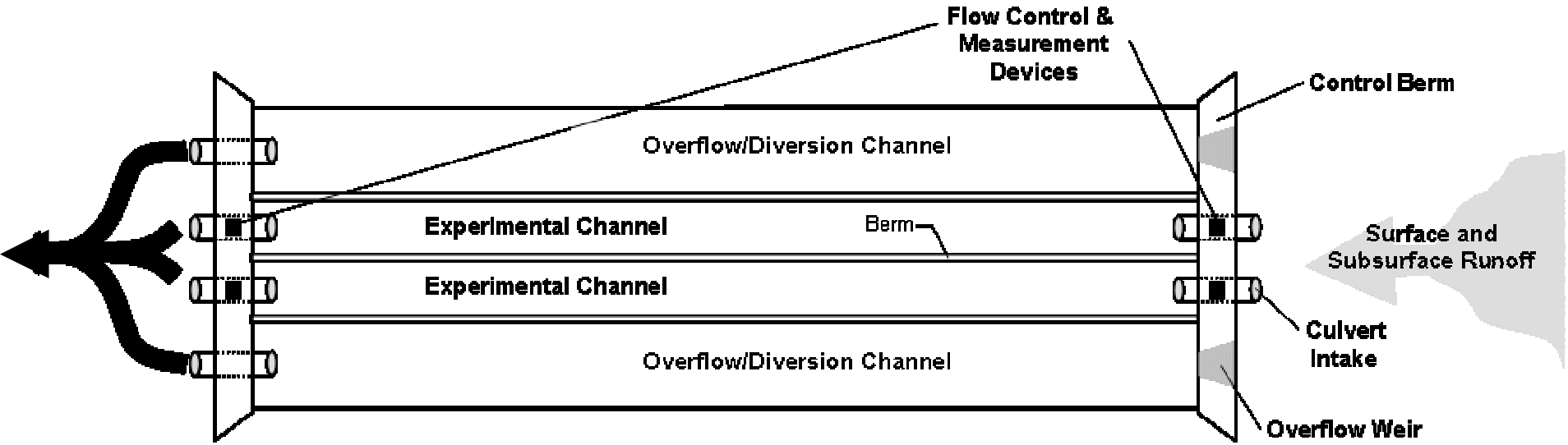
Summer – 2002

Summer – 2004

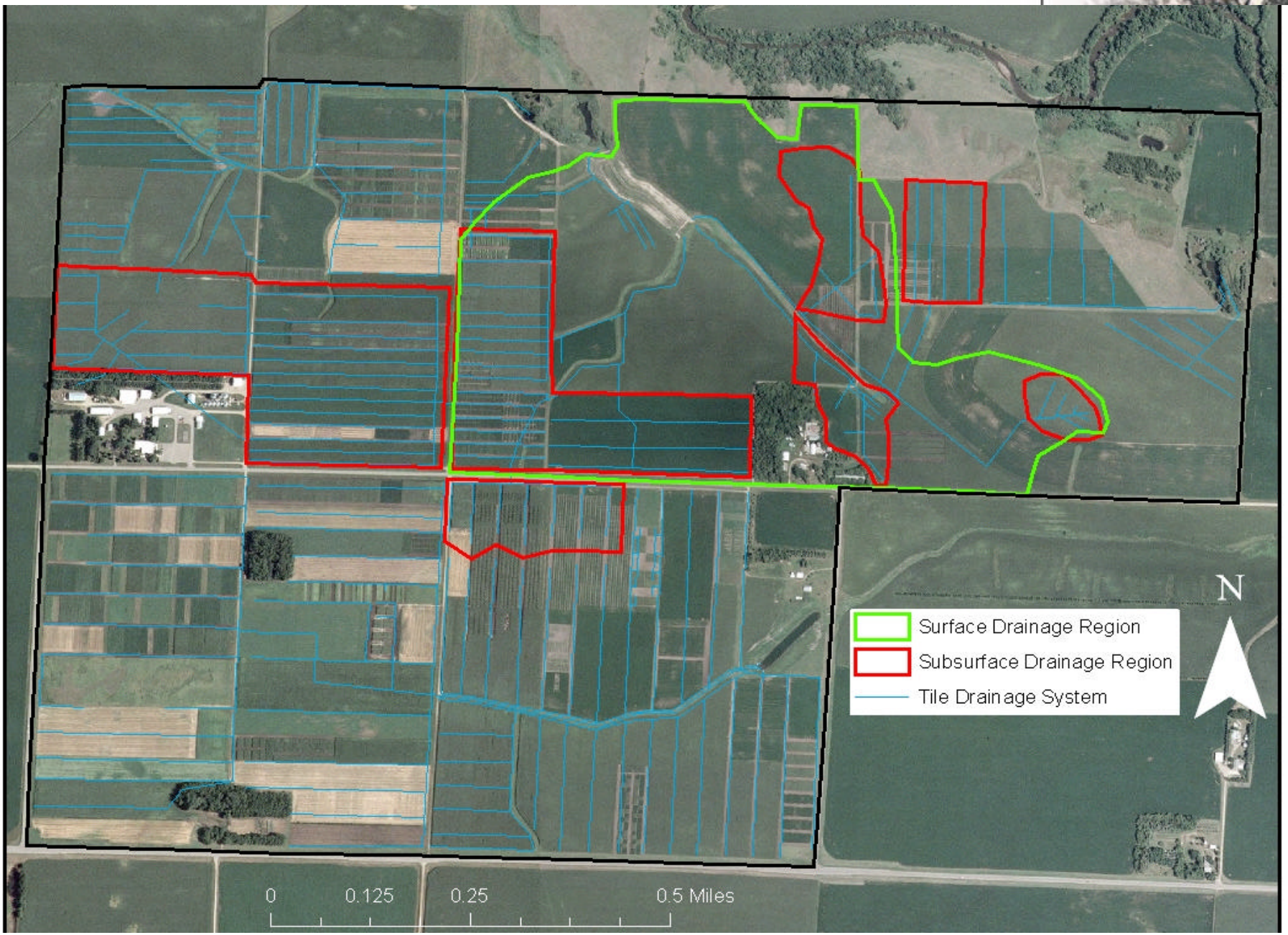
Autumn – 2002

Paired Design





Drainage Area

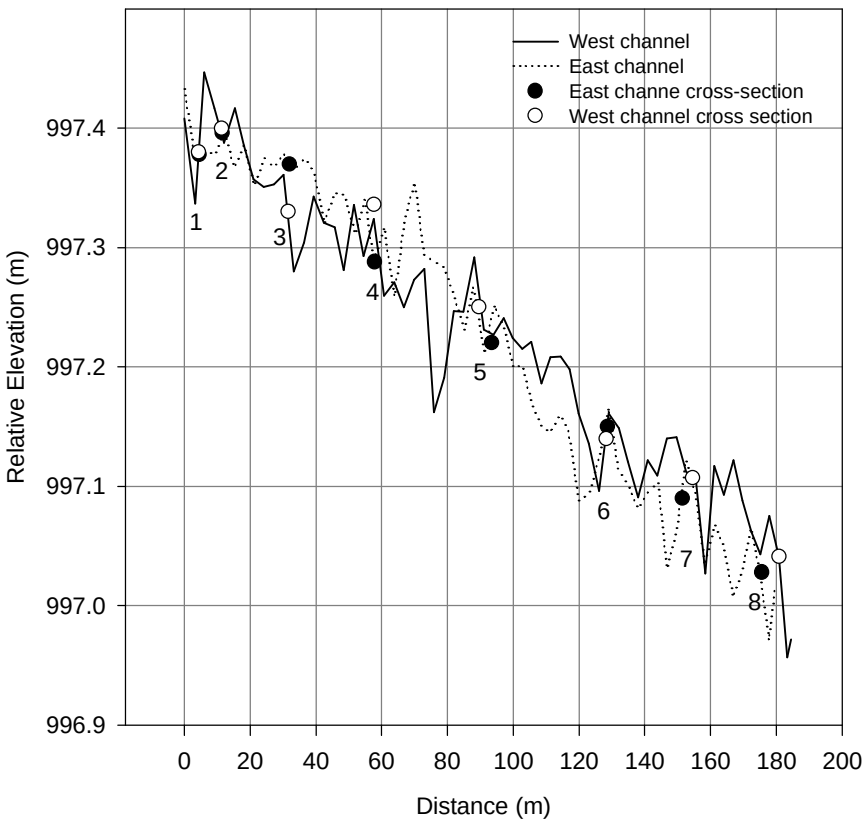


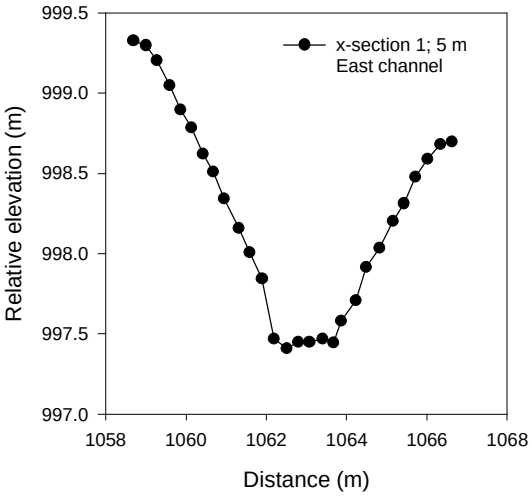
Data Collection

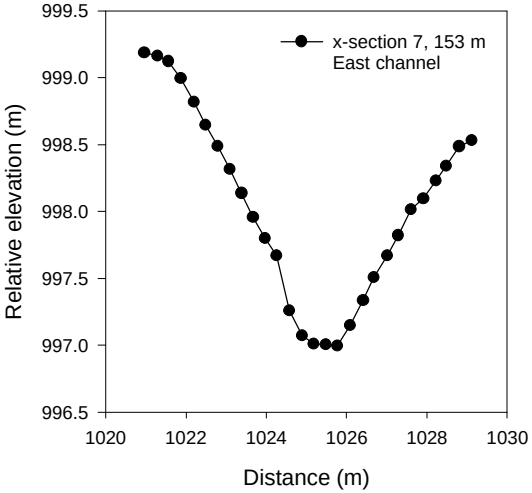
- Weekly grab samples
  - 1000 mL sample
  - NO_3-N, NH_4-N, Total N, Dissolved Reactive-P (DRP), Total P.
  - Flow
- Water properties
  - pH, specific conductance, temperature, dissolved-oxygen, oxidation-reduction potential.
- Storm events
  - Up to 24, 1000 mL samples.
  - NO_3-N, NH_4-N, Total N, DRP, Total P, sediment.
  - Flow.

MORPHOLOGY
&
HYDROLOGY

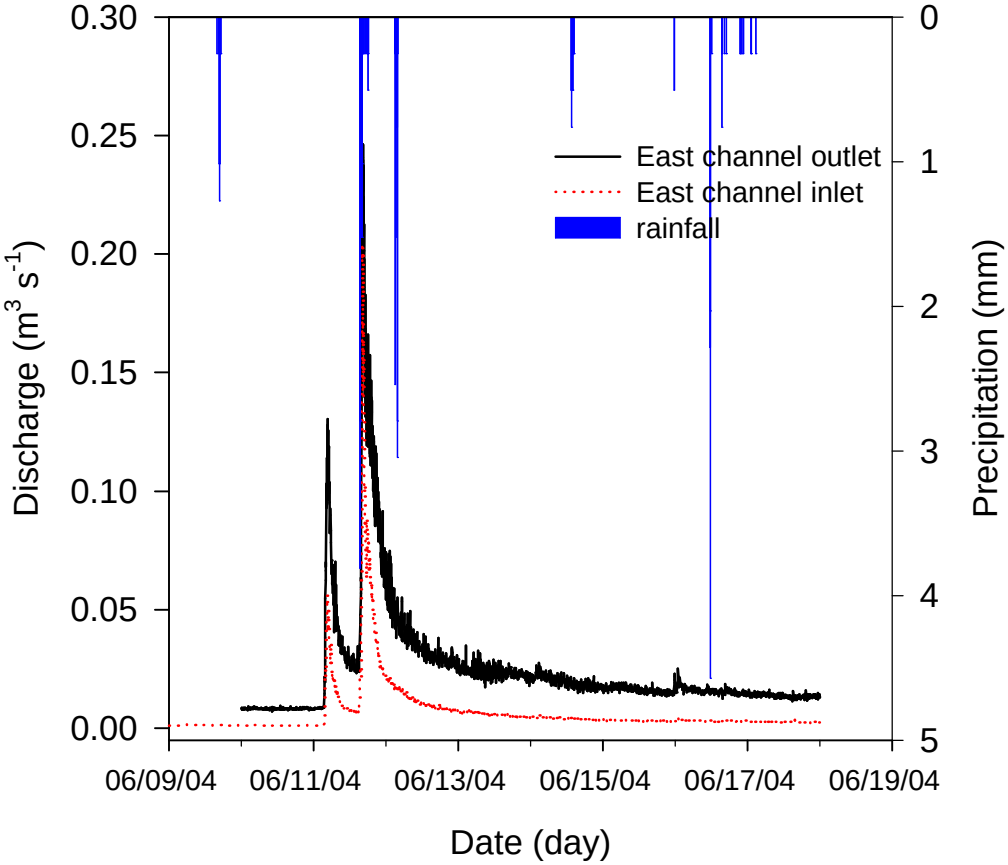
Morphology


West channel
East channel
East channe cross-section
West channel cross section
Relative Elevation (m)
997.4
997.3
997.2
997.1
997.0
996.9
0
20
40
60
80
100
120
140
160
180
200
Distance (m)
1
2
3
4
5
6
7
8


x-section 1; 5 m
East channel
Relative elevation (m)
999.5
999.0
998.5
998.0
997.5
997.0
1058
1060
1062
1064
1066
1068
Distance (m)


x-section 7, 153 m
East channel
Relative elevation (m)
999.5
999.0
998.5
998.0
997.5
997.0
996.5
1020
1022
1024
1026
1028
1030
Distance (m)

Hydrology


0.30
0.25
0.20
0.15
0.10
0.05
0.00
Discharge (m3 s-1)
0
1
2
3
4
5
Precipitation (mm)
East channel outlet
East channel inlet
rainfall
06/09/04
06/11/04
06/13/04
06/15/04
06/17/04
06/19/04
Date (day)

WATER QUALITY

Loads – 12 June, 2004 storm

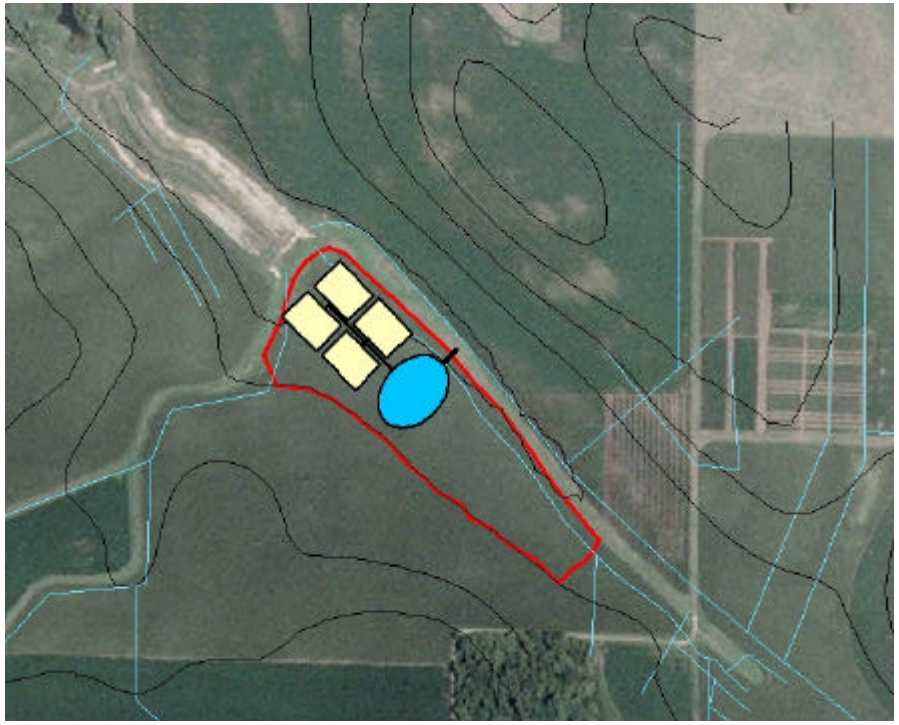
	Drainage	TSS	DRP	Total P	NH-$_4$N	NO$_3$-N
	cm	Mg	---------- kg ----------			
East inlet	0.3	1.3	0.4	3.7	0.6	33
East outlet	1.4	4.7	2.4	10.6	0.6	304
West inlet	0.2	0.5	0.2	2.2	0.5	45
West outlet	0.4	2.4	0.6	5.7	0.2	51

EDGE-OF-FIELD

Wetland – Reservoir Design

- Design concept modeled after the USDA-ARS Soil Drainage Research Unit's WRSIS (Wetland Reservoir SubIrrigation System)

- Wetlands will use a paired-design approach and return flow from reservoir will either enter the ditch system or a water table management experimental site.



Summary

- No one type of management practice is a silver bullet.
- In most situations, implementation of several practices will be necessary to build a sustainable farm management system that is productive, profitable, and environmentally acceptable.
- Maximum benefit will be achieved by targeting areas where water pollution risk is greatest.

THANK YOU!

jstrock@umn.edu
507-752-5064