Nutrient Loads in Ohio Headwater Streams

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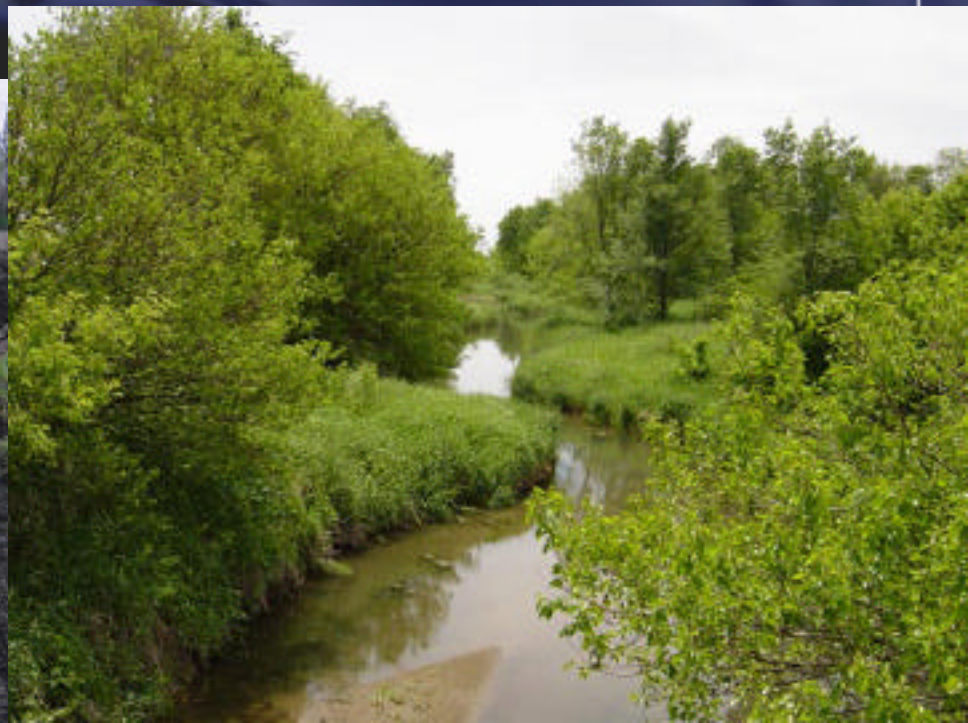
Canada
United States
Mexico

Outline

- Ohio Headwater Streams
- Two-Stage Drainage Channel Design
- Nutrient Study Overview of Two-Stage Channels
- Two-Stage Channel Stability

Ohio Headwater Streams

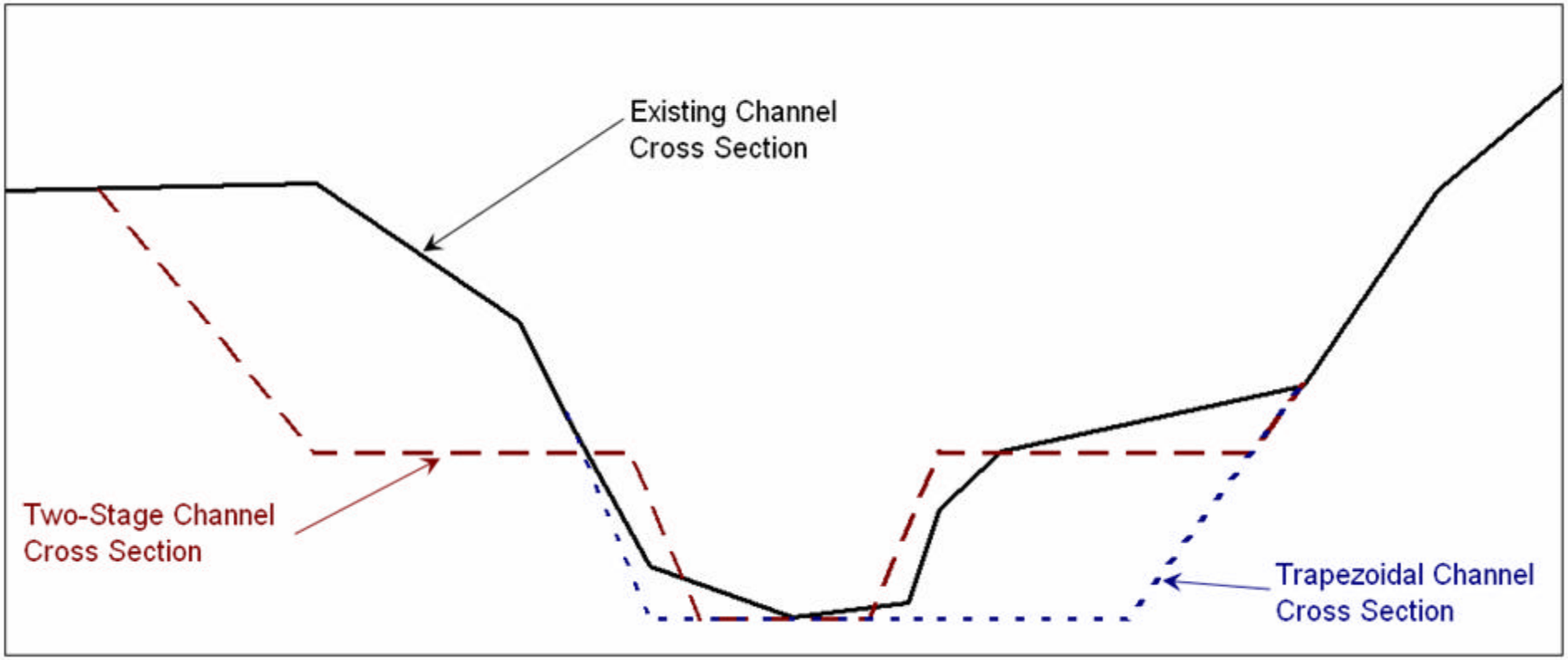
- Facilitate Agricultural Drainage
- Low Gradient
- Deepened and Straightened
- Routinely Maintained

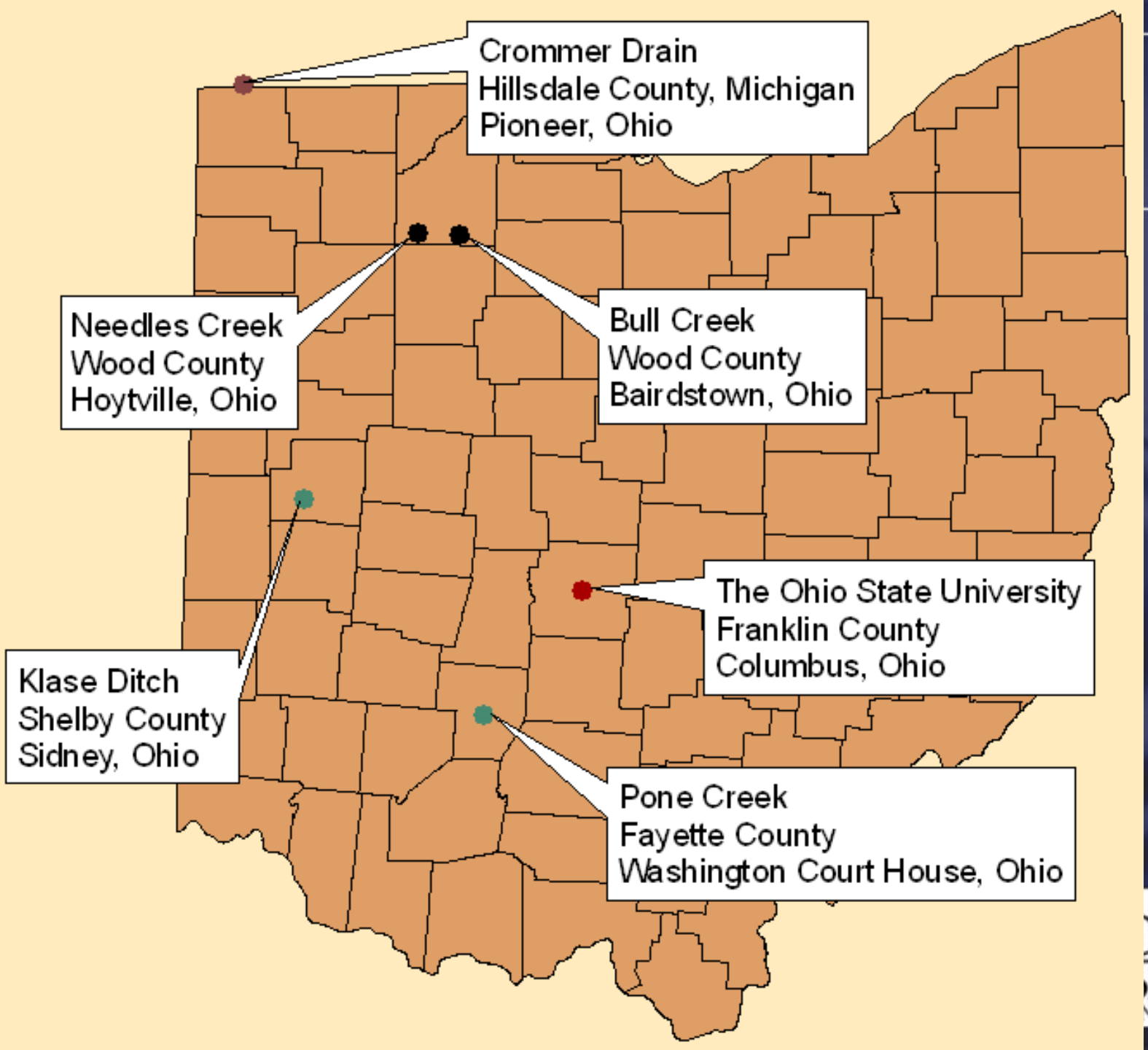


Overview

- Assess Water Quality from Agricultural Channels Designed with Geomorphic Features
- Possible Best Management Practice

Two-Stage Channel Design




Crommer Drain
Hillsdale County, Michigan
Pioneer, Ohio
Needles Creek
Wood County
Hoytville, Ohio
Bull Creek
Wood County
Bairdstown, Ohio
The Ohio State University
Franklin County
Columbus, Ohio
Klase Ditch
Shelby County
Sidney, Ohio
Pone Creek
Fayette County
Washington Court House, Ohio

Nutrient Sampling

- April 2004 – November 2005
- Composite Sampling
- Flow Record
- Upstream/Downstream
- 1547 Samples
  - 11291 Events

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Nutrient Analysis

- National Center for Water Quality Research at Heidelberg College
  - Ammonium
  - Chloride
  - Sulfate
  - Nitrite
  - Nitrate
  - Silicates
  - Soluble Reactive Phosphorus
  - Total Phosphorus
  - Total Kjeldahl Nitrogen
  - Suspended Solids
  - Fluoride

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Pone Creek

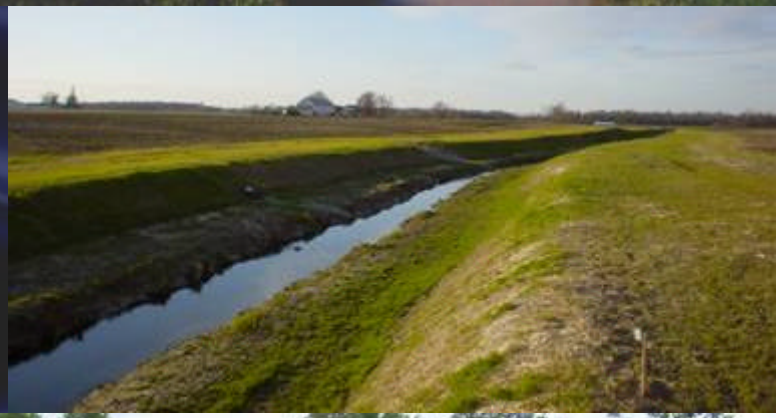
- Samplers 10000 Feet Apart
- 2.5 mi^2 Drainage Area
- 99% Agricultural Land Use
- B Soils
- 0.25% Channel Slope

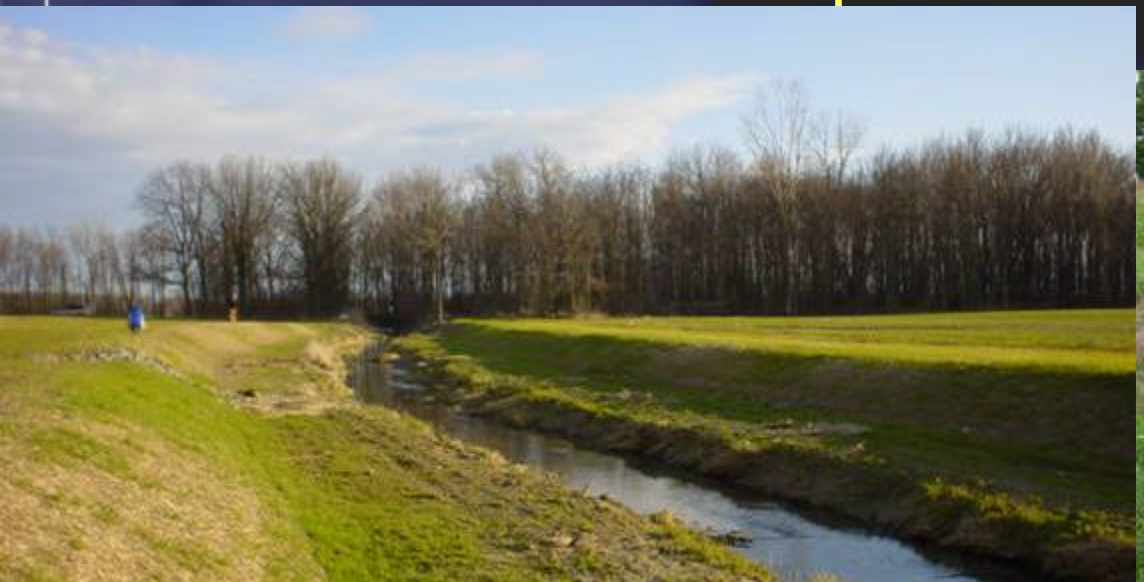
Klase Ditch

- Samplers 2500 Feet Apart
- 2.7 mi^2 Drainage Area
- 97% Agricultural Land Use
- C Soils
- 0.15% Channel Slope

Crommer Drain

- Samplers 2100 Feet Apart
- 4.5 mi^2 Drainage Area
- 82% Agricultural Land Use
- B and C Soils
- <0.1% Channel Slope





Bull Creek

- Samplers 1100 Feet Apart
- 4 mi^2 Drainage Area
- 97% Agricultural Land Use
- C Soils
- 0.2% Channel Slope

Needles Creek

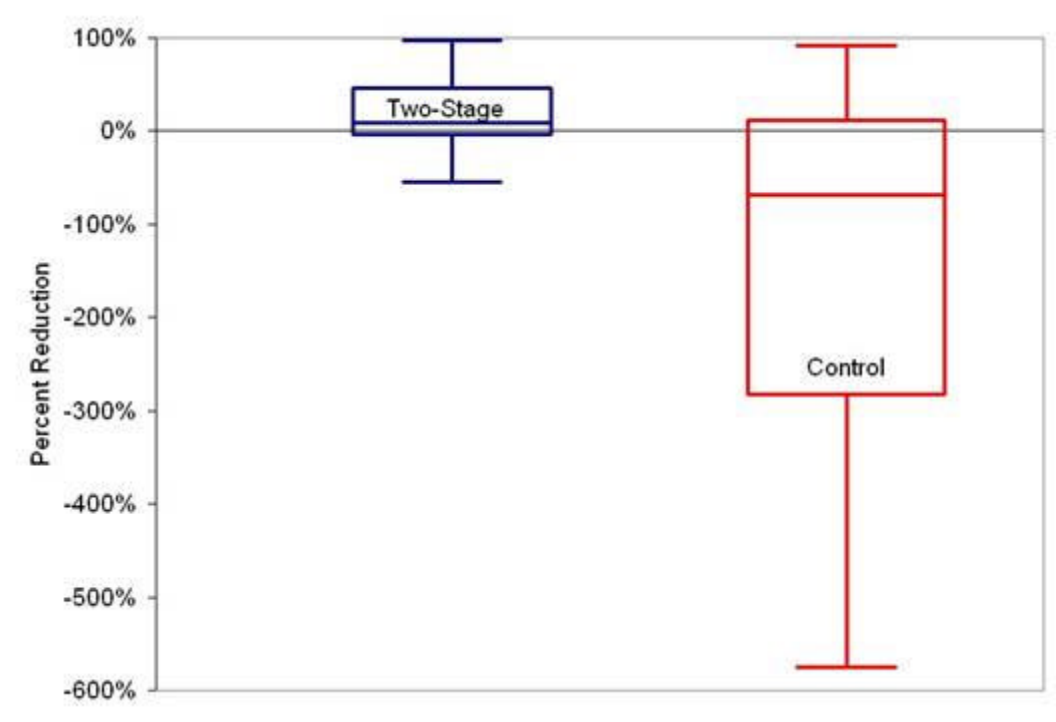
- Samplers 1300 Feet Apart
- 11 mi^2 Drainage Area
- 99% Agricultural Land Use
- C and D Soils
- 0.15% Channel Slope

Crommer Drain – Control

- Samplers 4000 Feet Apart
- 4 mi^2 Drainage Area
- 82% Agricultural Land Use
- B and C Soils
- <0.1% Channel Slope

Nitrate

- Average
  - Upstream:
    - 4.3 mg/L (0.2 mg/L)
  - Downstream:
    - 3.7 mg/L (0.2 mg/L)
  - 14% Reduction
- Control
  - 16% Increase



Bull Creek	-2%
Crommer Drain	30%
Klase Ditch	31%
Needles Creek	-2%
Pone Creek	9%
Control	-16%

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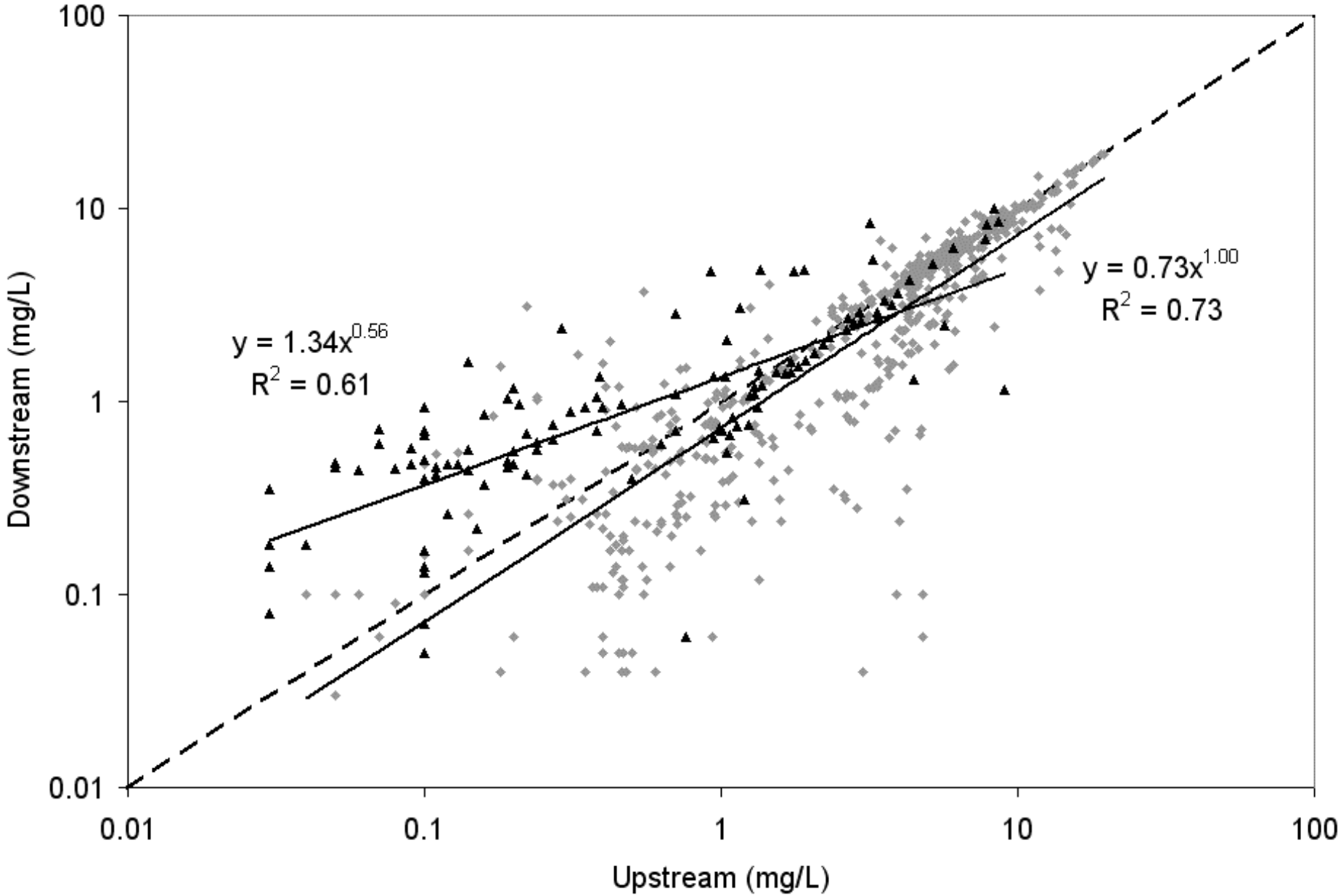
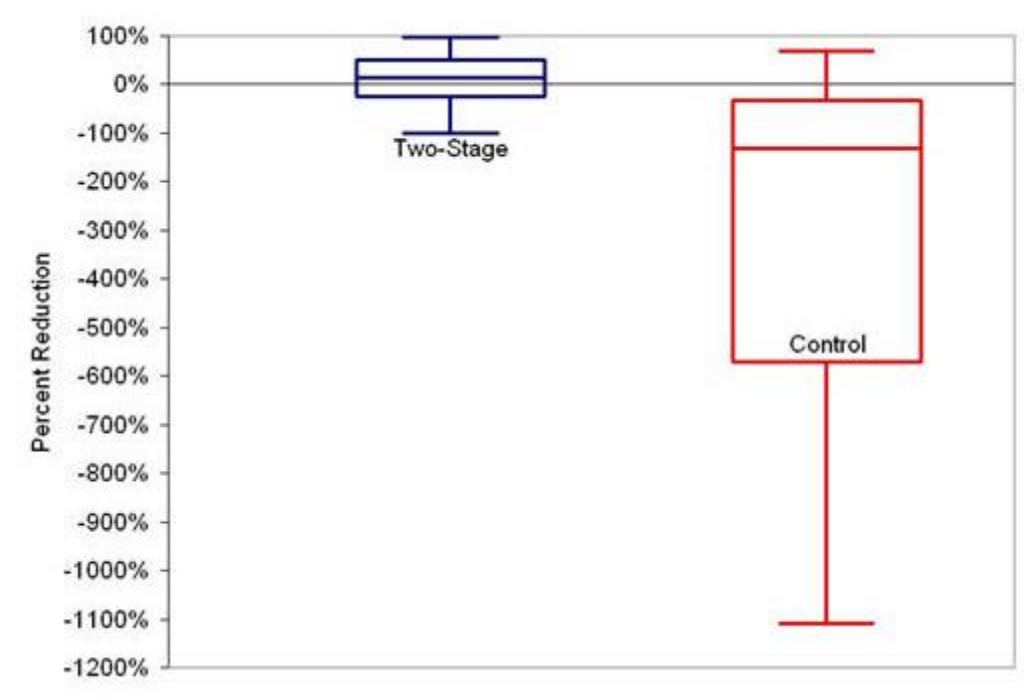
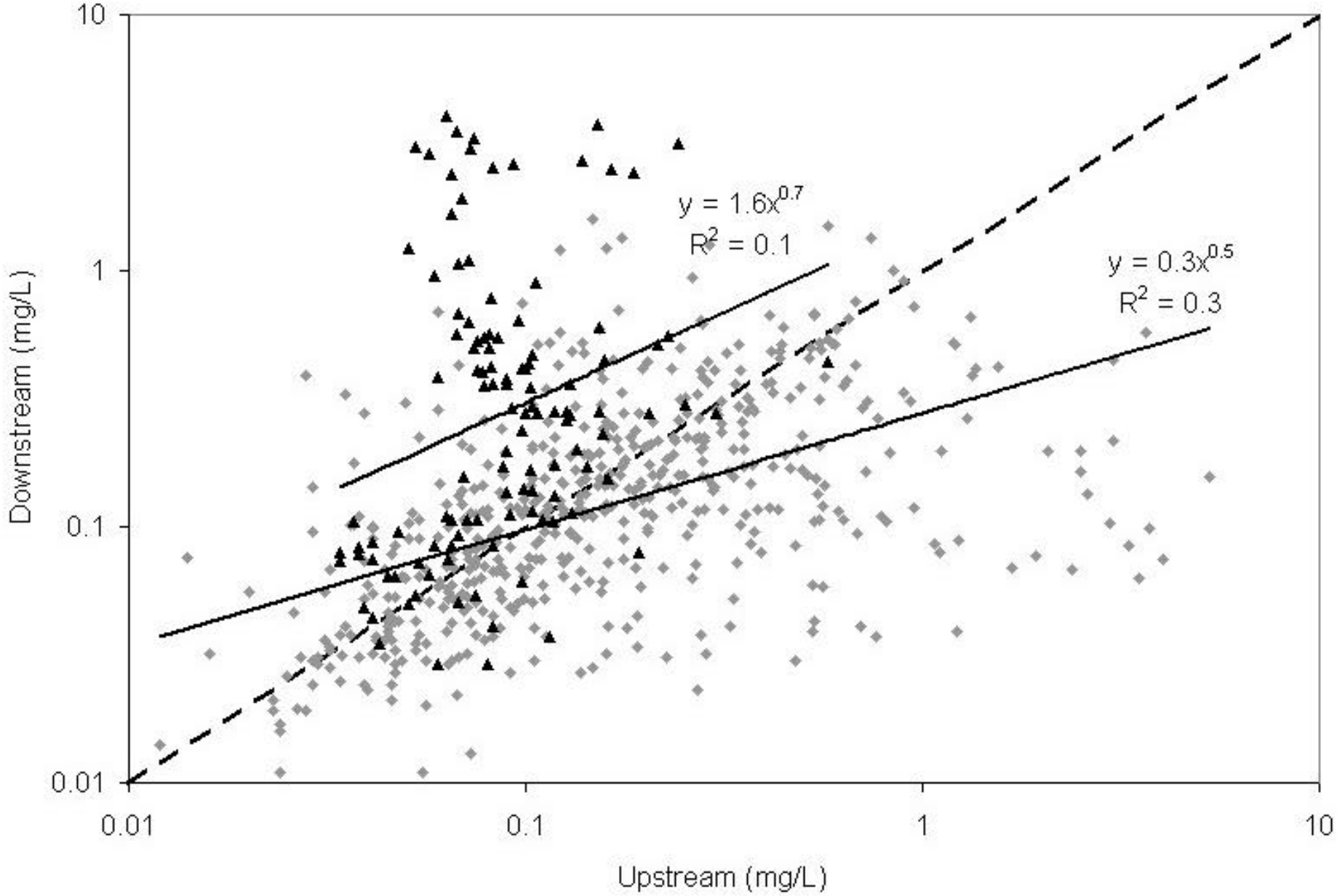

100
10
1
0.1
0.01
Downstream (mg/L)
0.01
0.1
1
10
100
Upstream (mg/L)
y = 1.34x^0.56
R^2 = 0.61
y = 0.73x^1.00
R^2 = 0.73

Total Phosphorus

- Average
  - Upstream
    - 0.31 mg/L (0.02 mg/L)
  - Downstream
    - 0.19 mg/L (0.01 mg/L)
  - 40% Reduction
- Control
  - >100% Increase

Bull Creek	6%
Crommer Drain	58%
Klase Ditch	38%
Needles Creek	-12%
Pone Creek	37%
Control	-100%

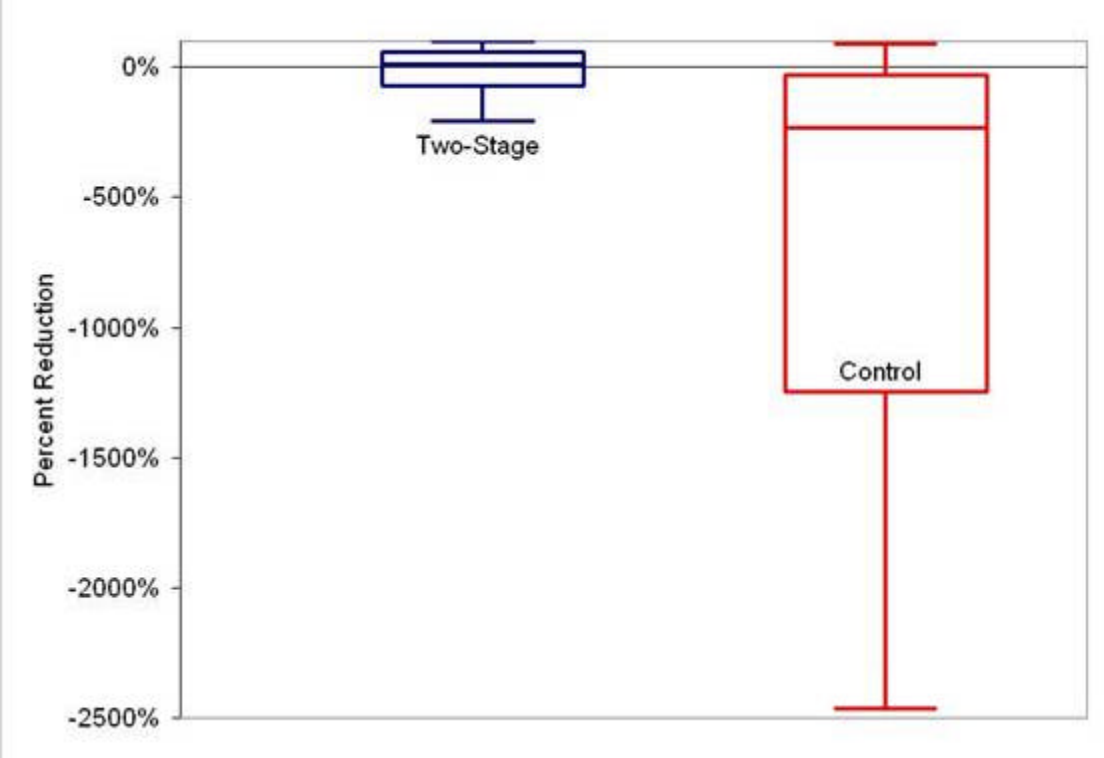


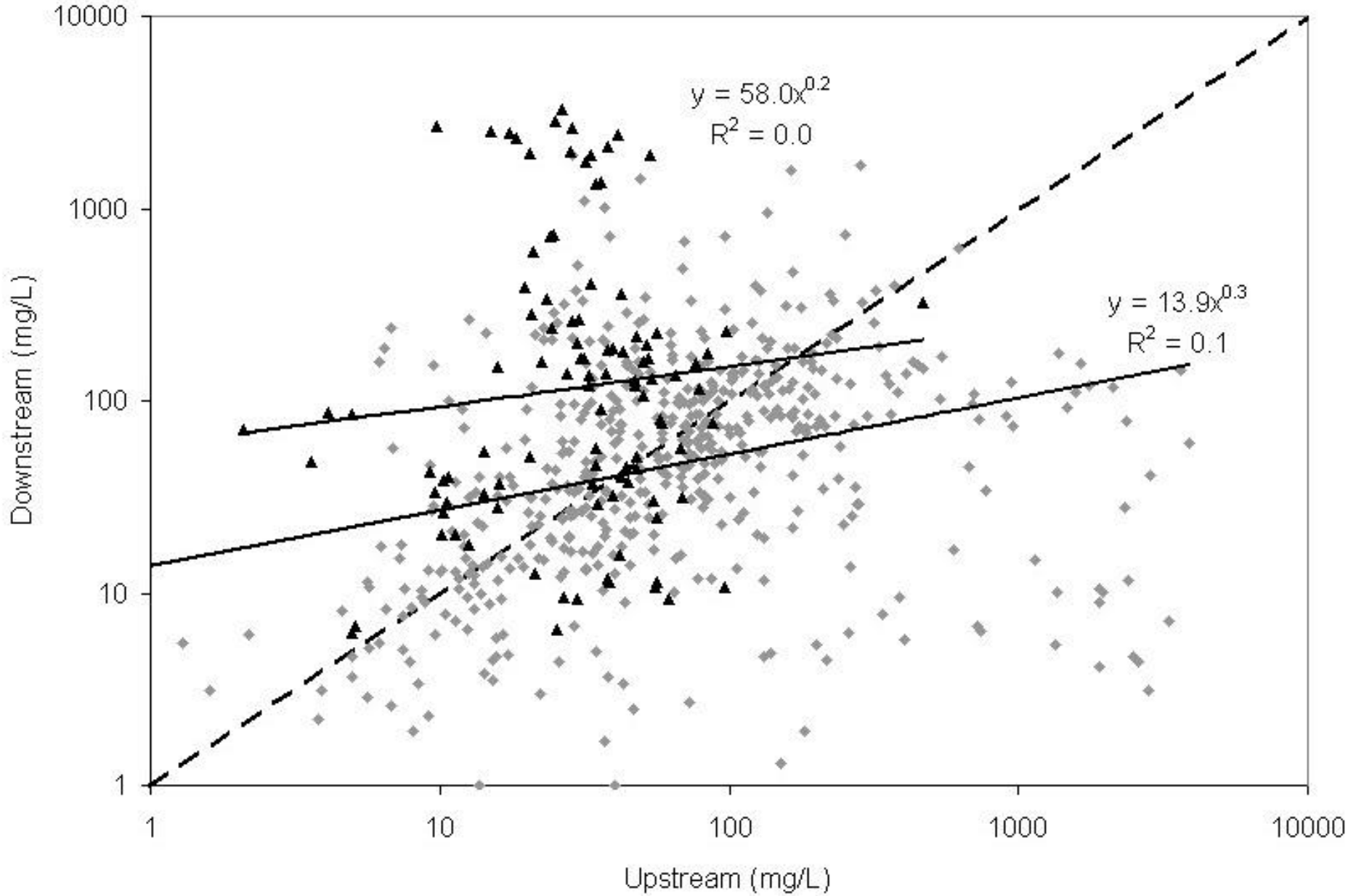

10
1
0.1
0.01
0.01
0.1
1
10
Downstream (mg/L)
Upstream (mg/L)
y = 1.6x^0.7
R^2 = 0.1
y = 0.3x^0.5
R^2 = 0.3

Suspended Solids

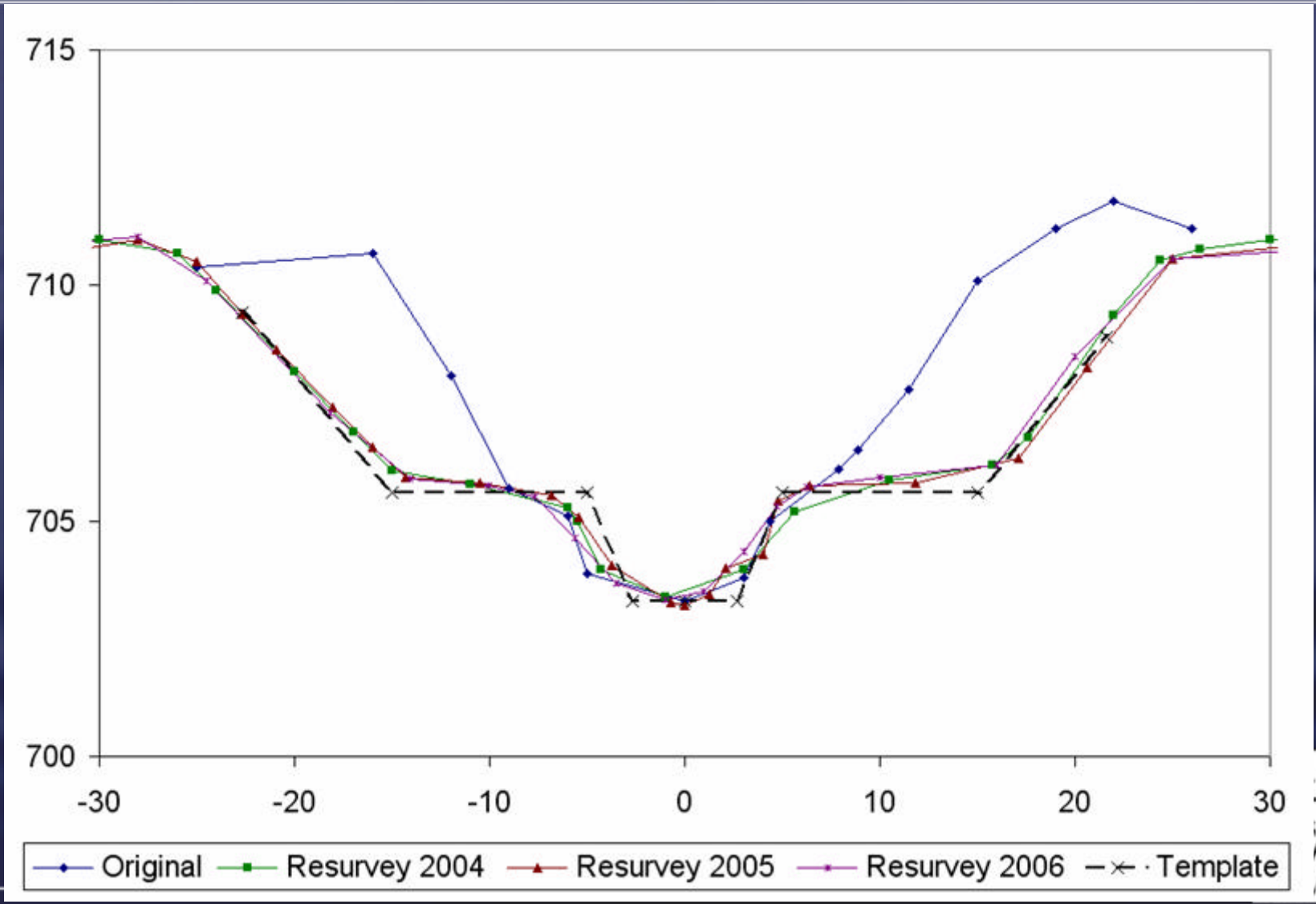
- Average
  - Upstream
    - 190 mg/L (21 mg/L)
  - Downstream
    - 100 mg/L (8 mg/L)
  - 46% Reduction
- Control
  - >100% Increase

Bull Creek	-19%
Crommer Drain	66%
Klase Ditch	32%
Needles Creek	-4%
Pone Creek	62%
Control	-100%




y = 58.0x^0.2
R^2 = 0.0
y = 13.9x^0.3
R^2 = 0.1
10000
1000
100
10
1
Downstream (mg/L)
1
10
100
1000
10000
Upstream (mg/L)

Two-Stage Channel Stability



Conclusions

1. Water Quality Effluent Improved in Two Stage Channels in Comparison to Trapezoidal Agricultural Channels
2. Two Stage Channels are Stable
3. Possible Best Management Practices for Agricultural Channel Maintenance

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Thank You
Questions?