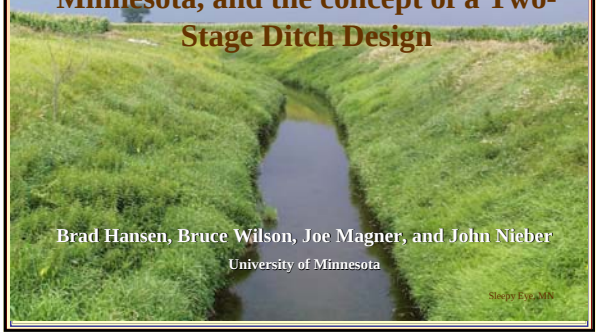
Geomorphic Characteristics of Drainage Ditches in Southern Minnesota, and the concept of a Two-Stage Ditch Design



Brad Hansen, Bruce Wilson, Joe Magner, and John Nieber
University of Minnesota

Sleepy Eye, MN

Outline

- Background
- Site Selection
- Field Methods
- Results

Current Designs

- 27K miles in Mn
- Maintenance
- Biotic potential
- Blue Earth County
  - $650K in 2005
  - $1.2M in 2006
- Ohio
  - $450/mi/yr

Problem: Seepage-induced instabilities

Faribault County

Problem: Management of Surface Runoff

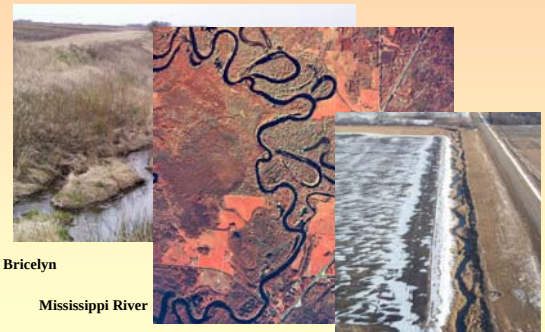
Faribault County

Problem: Design of surface inlets

Bare bank erosion

Faribault County

Problem: Natural geomorphoric processes



Bricelyn

Mississippi River

Jacobson

Ohio Design: Geomorphoric concepts

...ankfull discharge is the discharge that forms ...river channel shape becomes ... that carries most of the ... flood prone width is wide ... of channel when ... filled will spill over into the flood plain; defined as having twice the depth of bankfull.

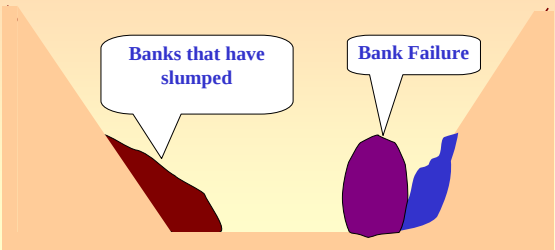
A Two Stage Channel

From J. D'Ambrosio et al.

Maintenance Often Removes Fluvial Benches That Will Rebuild Again

From J. D'Ambrosio et al.

Features due to Bank Failure are not Fluvial Benches

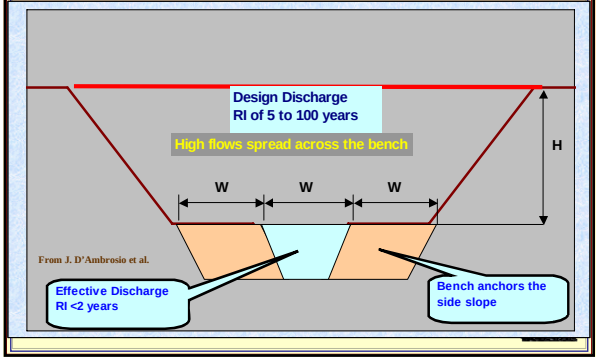


From J. D'Ambrosio et al.

Bank Failure in an Illinois Ditch

From J. D'Ambrosio et al.

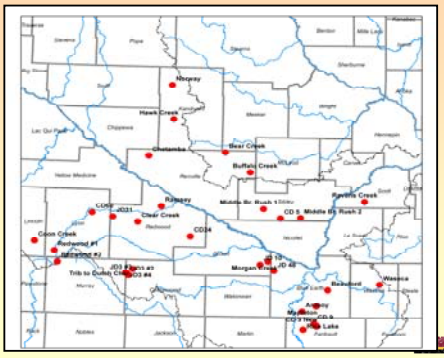
Bench Characteristics



Experimental Design

Category	Number of Sites	Definition
Old or not maintained	24	Presence of bankfull bench
New	6	Recently built, no bankfull bench
Natural Stream	6	Natural stream, never channelized

Site Locations

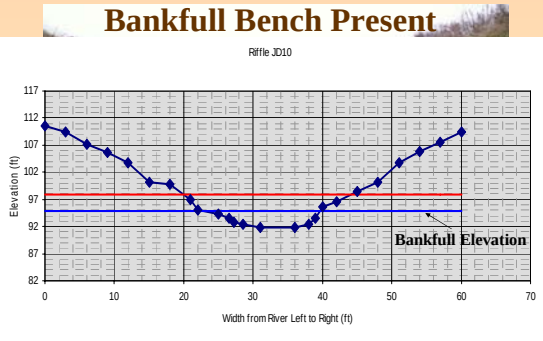


Range of Main Parameters

Parameter	Low	High
Drainage Area (mi^2)	2.26	223
Slope (%)	.0017	0.6
Bankfull Width (feet)	3.5	43.9
Bankfull Flow (CFS)	30	548

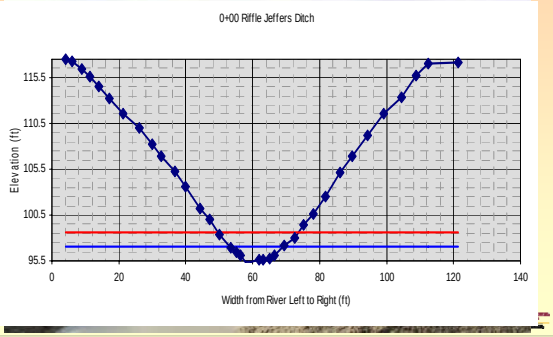
Not Recently Maintained: Bankfull Bench Present

New Ulm, Mn
JD 10



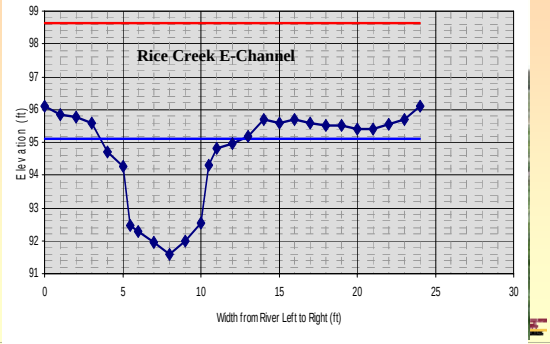
New Ditch: No Bench Formation

Delavan, Mn



Natural Streams

Mapleton, MN



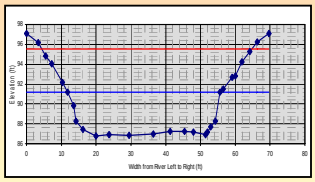
Field Methods

- Cross-section profile
- Longitudinal profile
- Pebble count

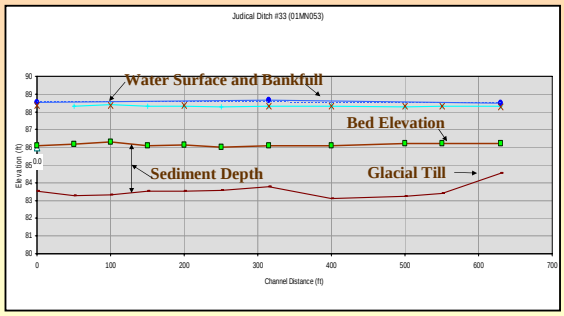
Marshall, Mn
Three Mile Creek

Cross-Sectional Data

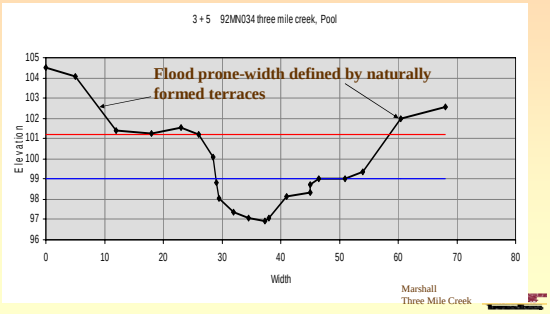
- Bankfull Width
- Bankfull Mean Depth
- Width/Depth Ratio
- Entrenchment Ratio
- Hydraulic Radius
- Wetted Perimeter



Longitudinal Profile

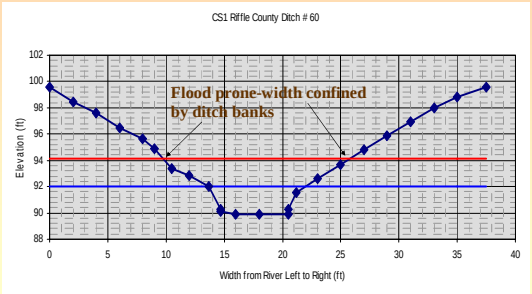


Entrenchment Ratio in a Natural Channel



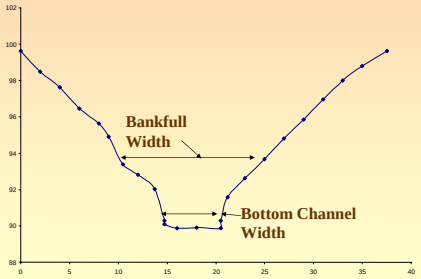
Marshall
Three Mile Creek

Entrenchment Ratio in a Ditch



Minnesota Entrenchment Ratio

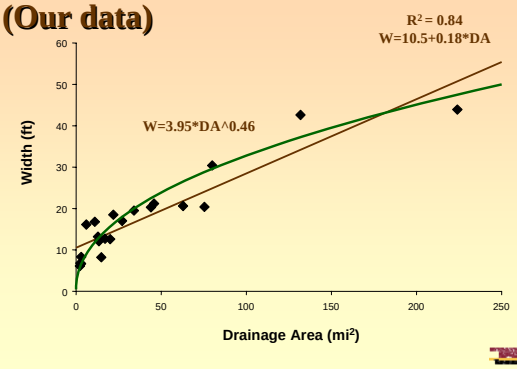
Bankfull Width / Bottom Channel Width



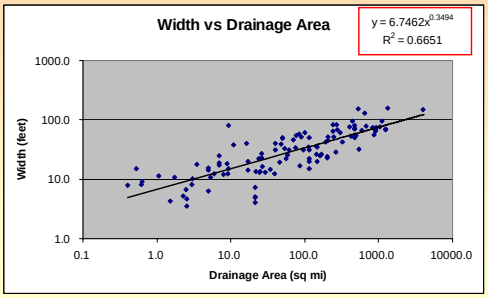
Geomorphoric Parameters

- Bankfull width
- Bankfull mean depth
- Cross-sectional area
- Wetted perimeter
- Hydraulic radius
- Width/depth ratio
- Entrenchment ratio
- Slope
- D50
- D84
- Minnesota entrenchment ratio
- Bottom channel width

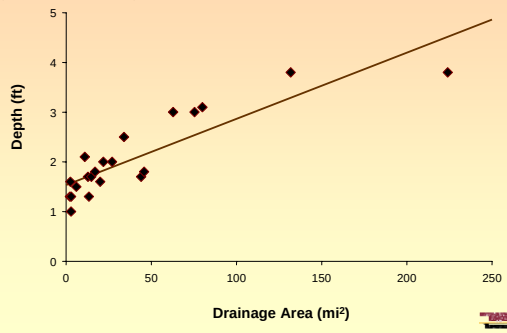
Bankfull Width (Our data)



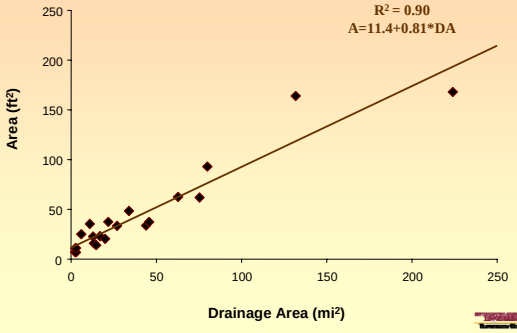
Width
(Our data and MNDNR data)



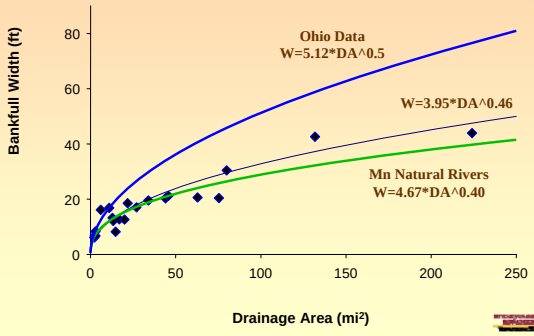
Bankfull Depth (Our data)



Bankfull Cross-Sectional Area (Our data)



Comparison with Natural Rivers



Reference for Stream Modules

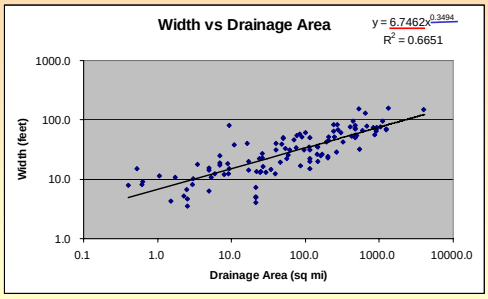
Dan Mecklenburg, OHDNR
Andy Ward, OSU

Has spreadsheet programs for doing all sorts of calculations for streams: e.g., two-stage channel design, reference reach module, sediment equations, flow regime equations, meander pattern module, etc.

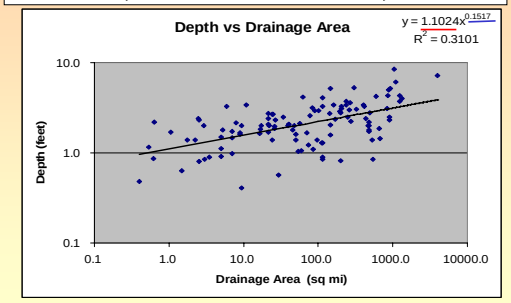
Look on the web at

http://www.ohiodnr.com/soilandwater/streammorphology.htm

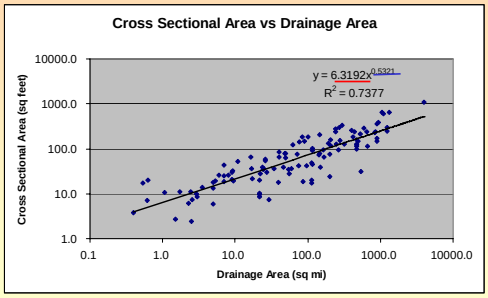
Width
(Our data and MNDNR data)



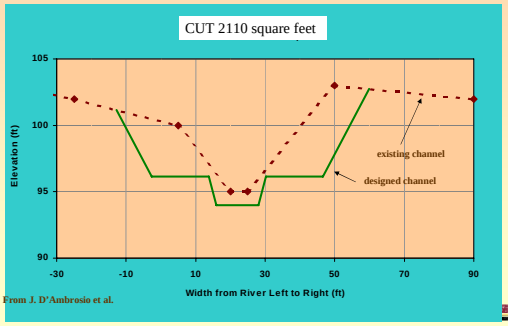
Depth
(Our data and MNDNR data)



Cross Sectional Area
(Our data and MNDNR data)



ODNR Ditch Design Spreadsheet

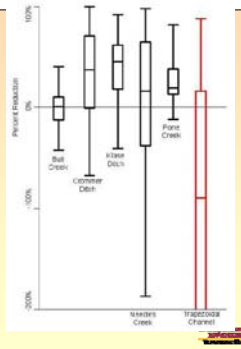


A Constructed Two Stage Channel

From J. D'Ambrosio et al.

Nitrate Load Percent Reduction

Site	Median Value
Bull Creek	1%
Crommer Drain	37%
Klase Ditch	45%
Needles Creek	16%
Pone Creek	20%
Trapezoidal	-86%

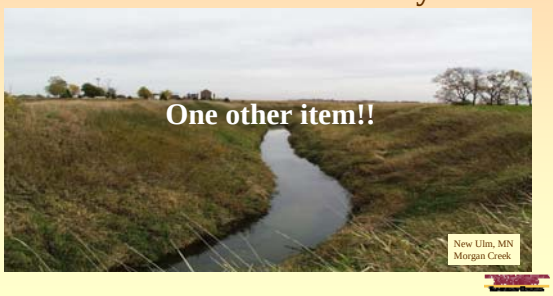


From J. D'Ambrosio et al.

Summary and Conclusion

- Need for self-sustaining designs
- More than one problem
- Defined two-stage design concept
- Data gathered on 30 ditches and 6 streams
- Geometry characteristics correlated to drainage area
- Ditch geometry consistent with natural streams
- Reduction in chemical contaminants in flows (Ohio study)

MADRAS
Minnesota Agricultural Ditch Reach Assessment for Stability



Comments/Questions