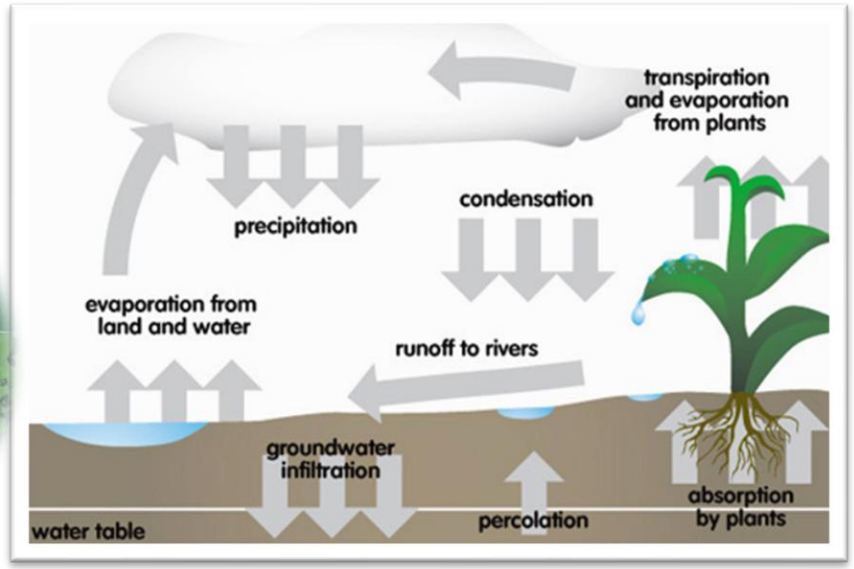






Strategic Framework to Guide Local Water Storage Implementation

Henry Van Offelen
Clean Water Specialist
Detroit Lakes

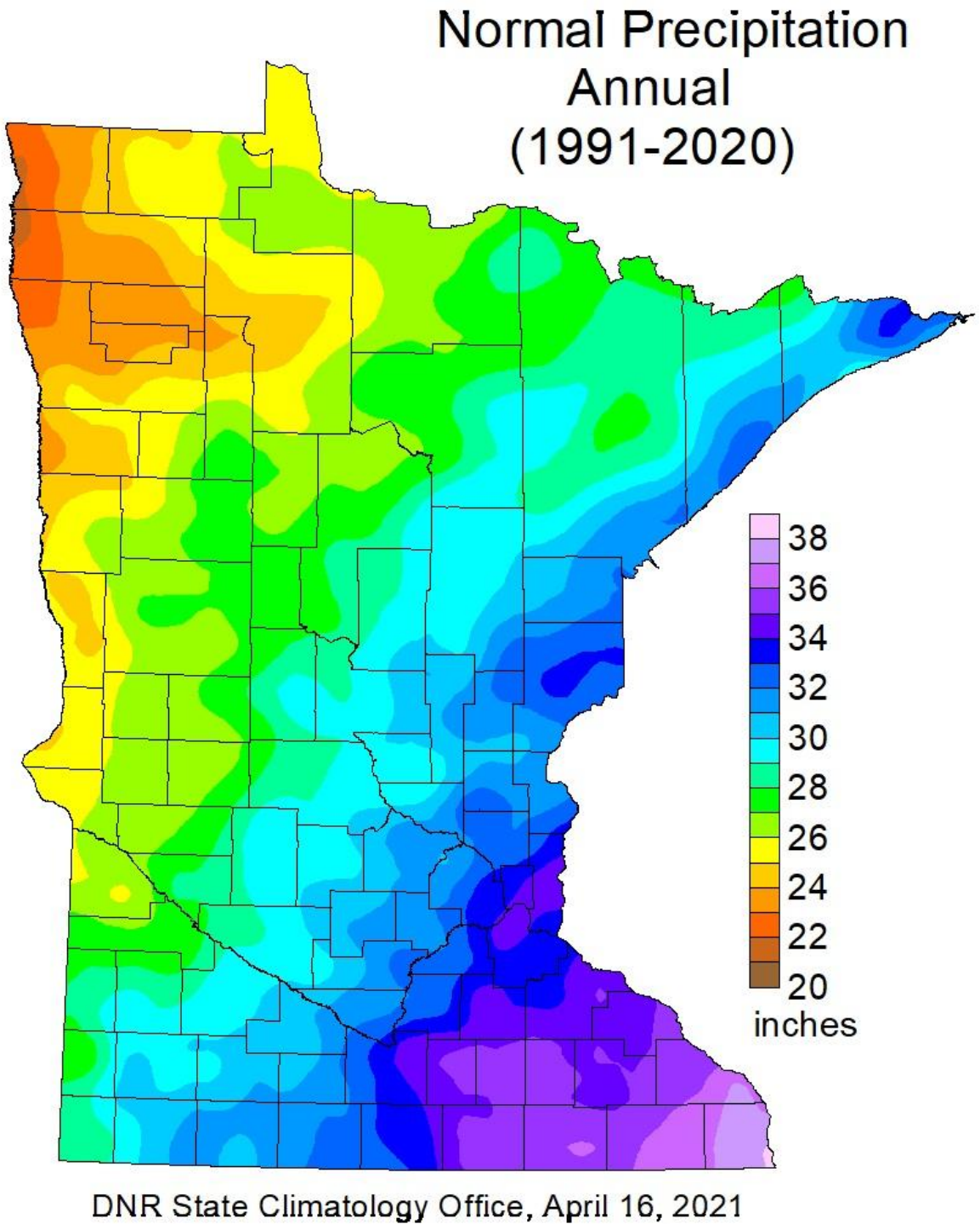
Ryan Hughes
Northern Regional Manager
Duluth

BOARD OF WATER AND SOIL RESOURCES

Key Messages

- Hydrology of MN Watersheds has changed and continues to change due to many factors.
- Increasing water storage on the landscape is critical to mitigating changes and increasing resiliency.
- Ongoing project that will use available Data / Models / Tools to work with local watershed implementers to systematically identify and evaluate water storage practices.

Precipitation



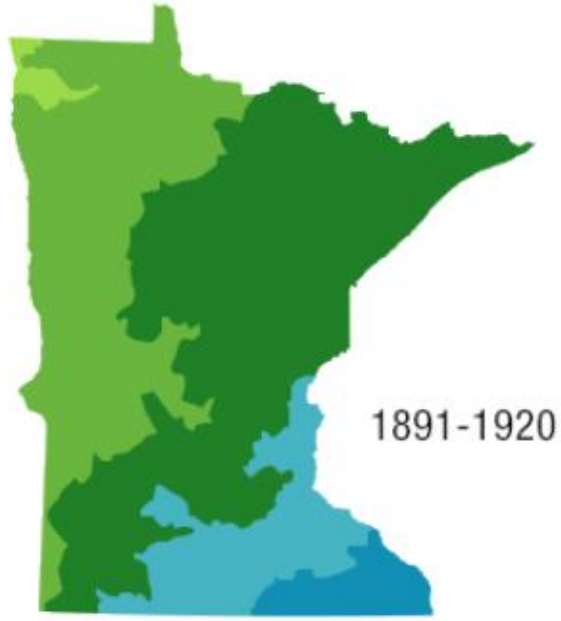
Average annual precipitation varies substantially northwest to southeast

(20 to 38 inches)

Precipitation change in Minnesota

Average Annual Rainfall

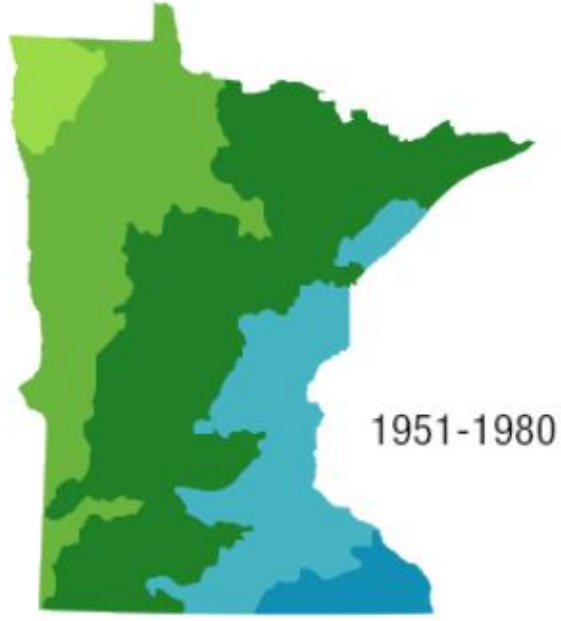
- Less than 20 inches
- 21-25 inches
- 26-28 inches
- 29-30 inches
- Greater than 30 inches



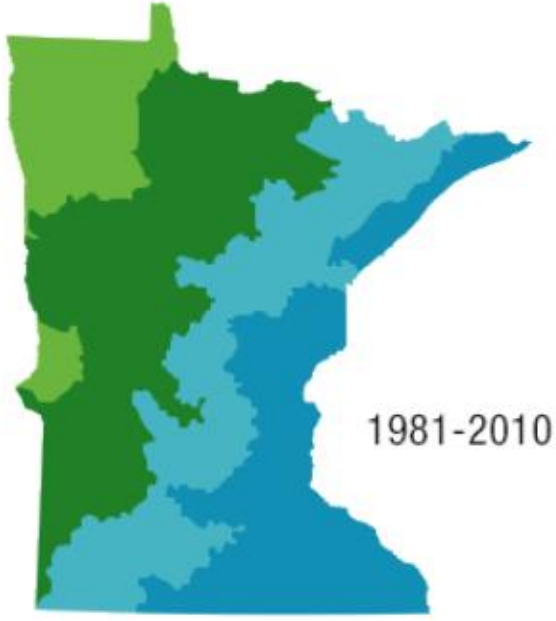
1891-1920



1921-1950



1951-1980



1981-2010

Source: Adopted from Gupta, S.C., A.C. Kessler, and M.K. Brown. 2014. Data from Minnesota Department of Natural Resources, state climatology office.

Historic changes in runoff ratio (runoff / precip)

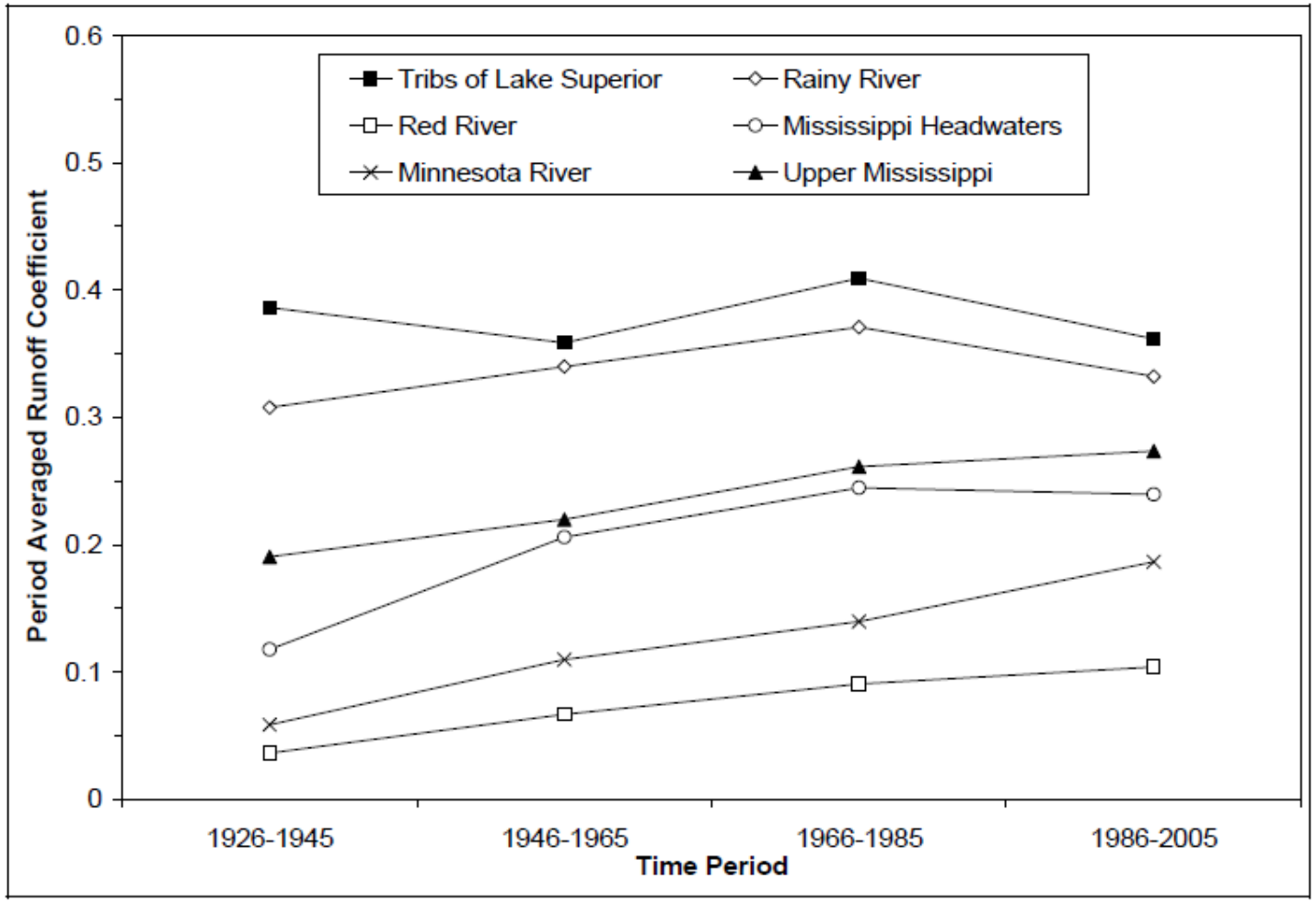


Figure 24: Runoff coefficients for lowest main stem stream in the major river basins of Minnesota over four time periods.

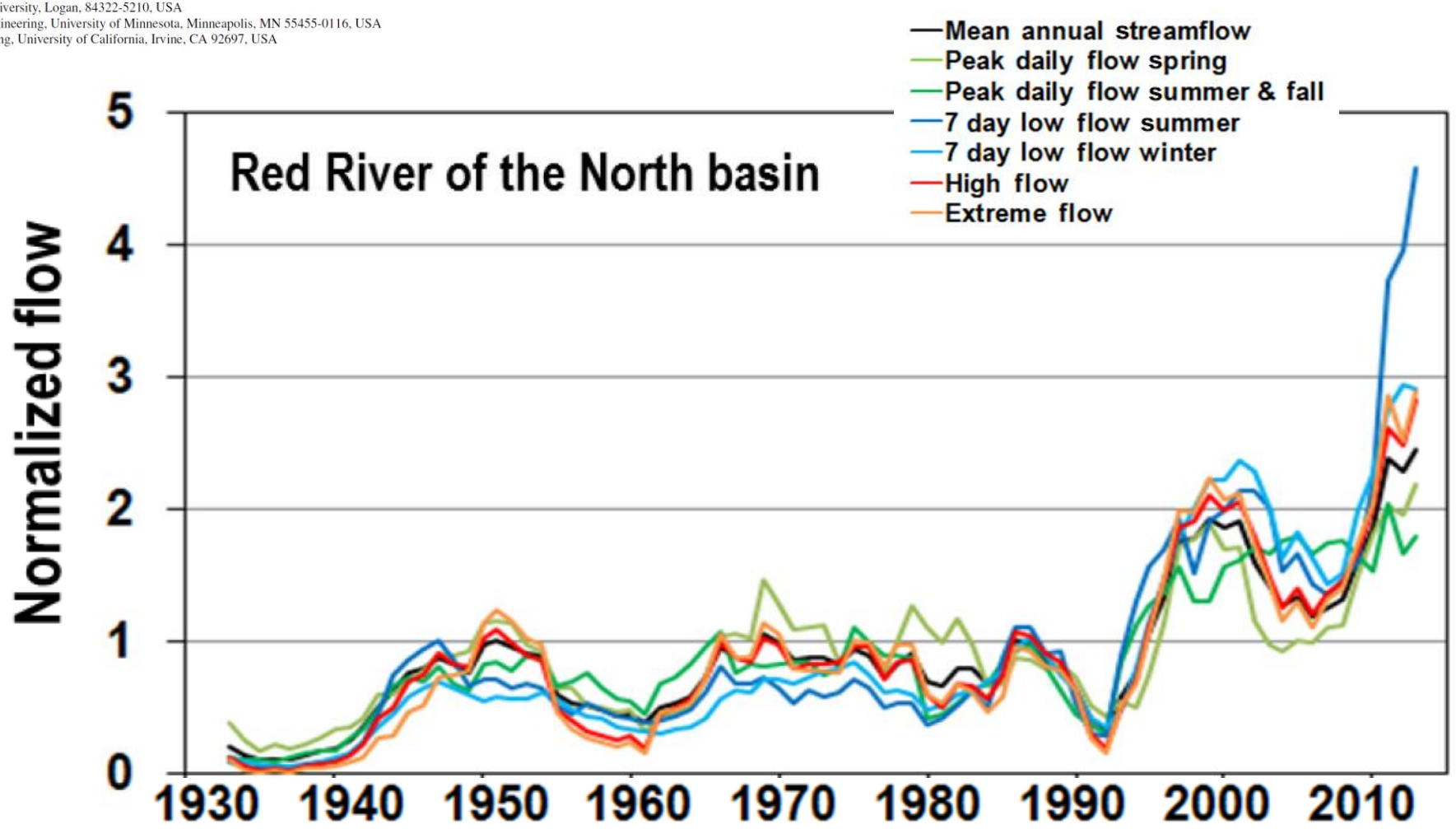
Source:
"Annual Stream Runoff and Climate in Minnesota's River Basins", Todd R. Vandegrift and Heinz G. Stefan, UMN SAFHL, September 2010

Historic changes

Human amplified changes in precipitation–runoff patterns in large river basins of the Midwestern United States

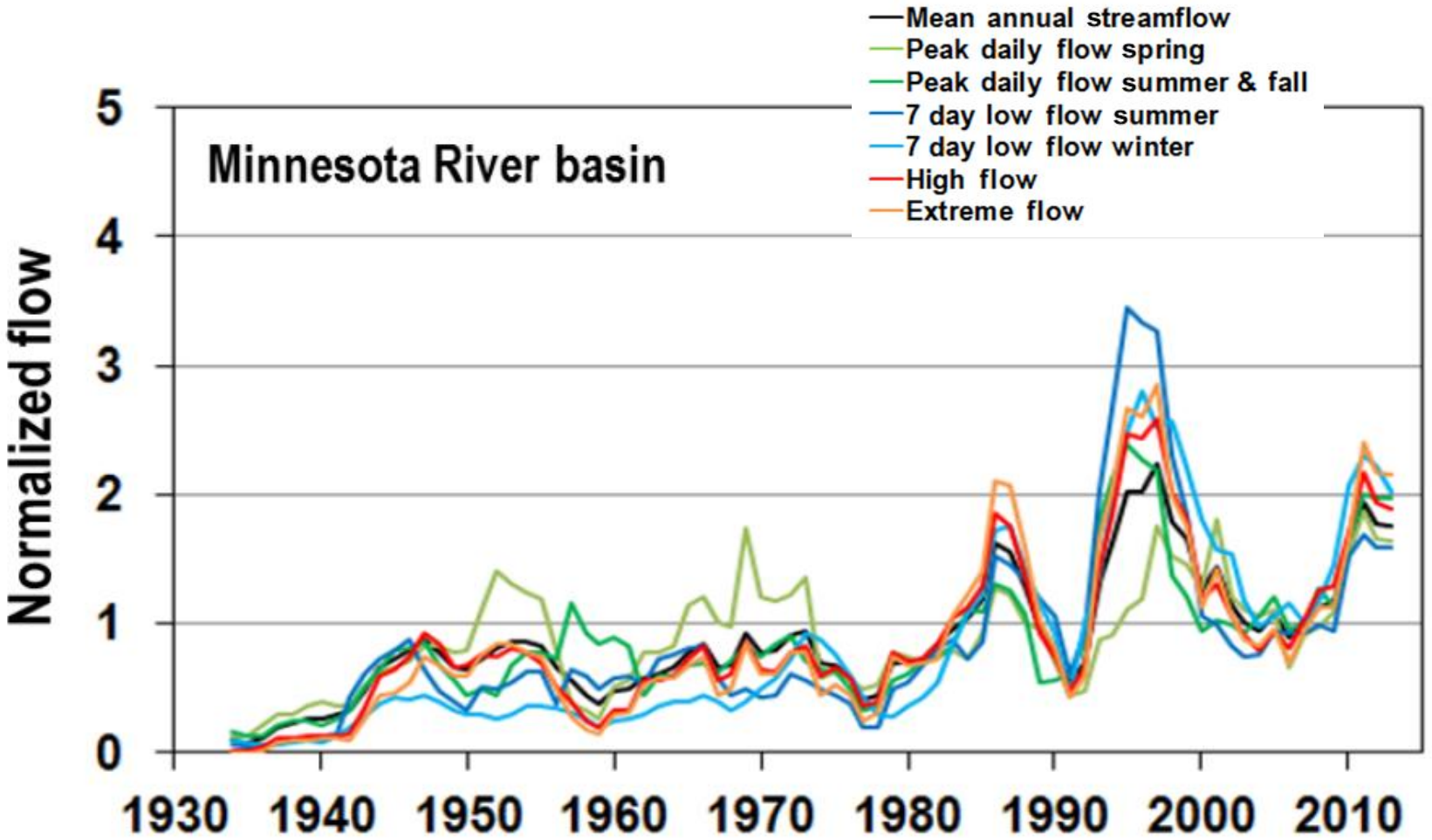
Sara A. Kelly[1], Zeinab Takbiri[2], Patrick Belmont[1], and Efi Foufoula-Georgiou[3]

[1]Department of Watershed Sciences, Utah State University, Logan, 84322-5210, USA
[2]Department of Civil, Environmental, and Geo-Engineering, University of Minnesota, Minneapolis, MN 55455-0116, USA
[3]Department of Civil and Environmental Engineering, University of California, Irvine, CA 92697, USA

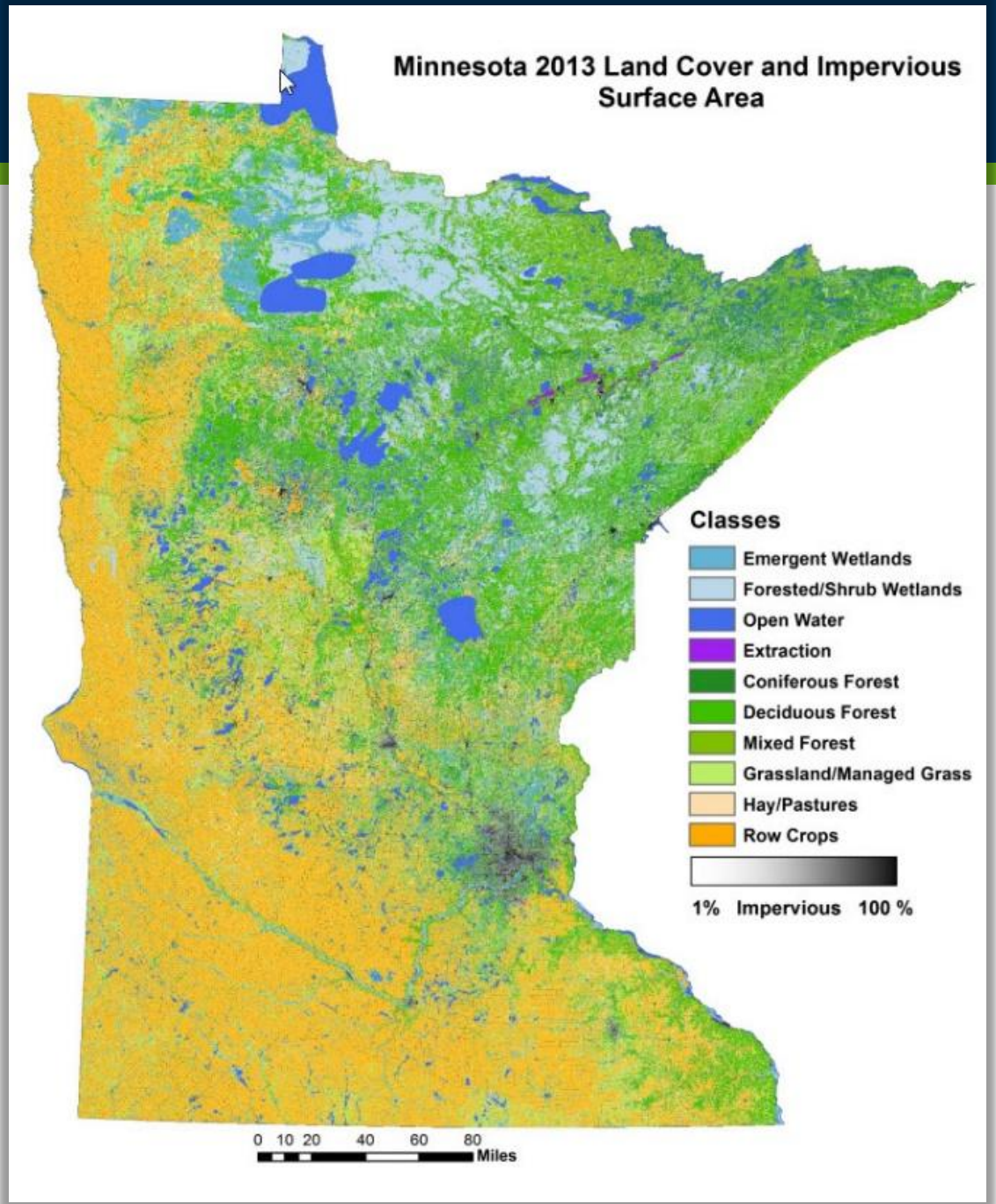


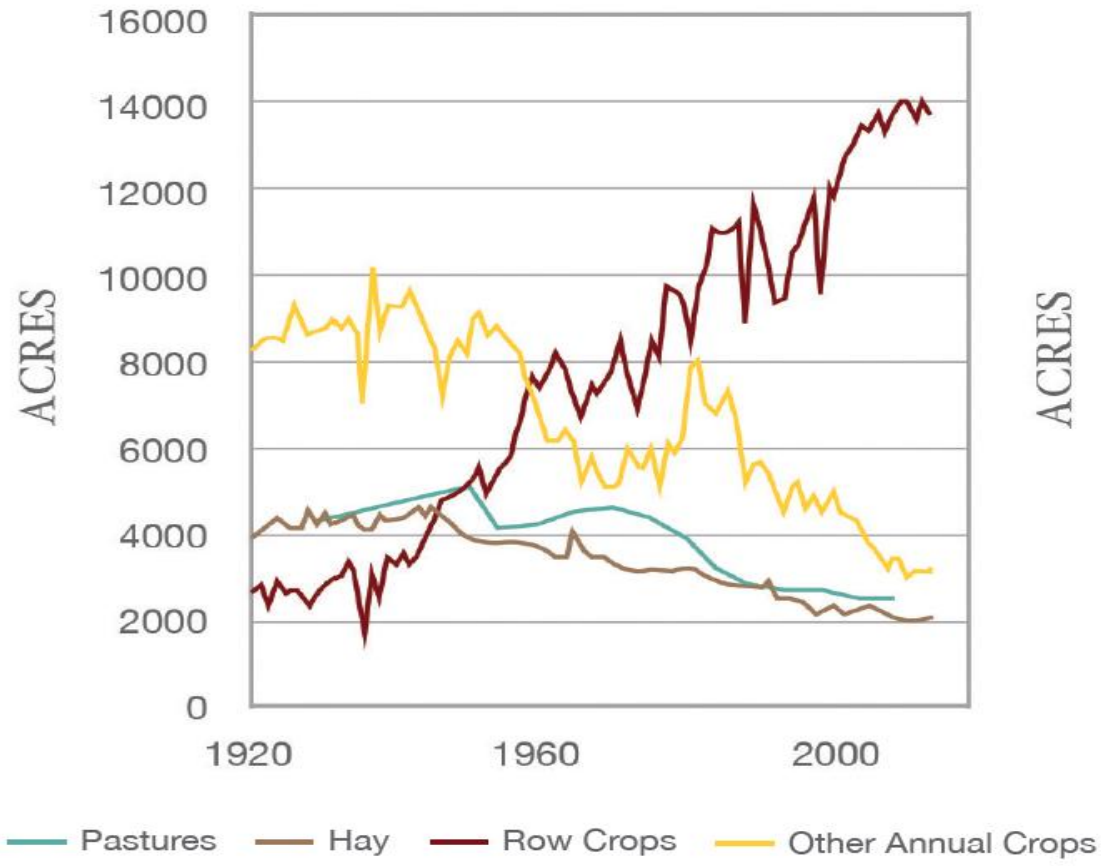
5-year running averages based on annual and daily gauge analysis for the Red River of the North basin, 22 gauges.

Historic changes



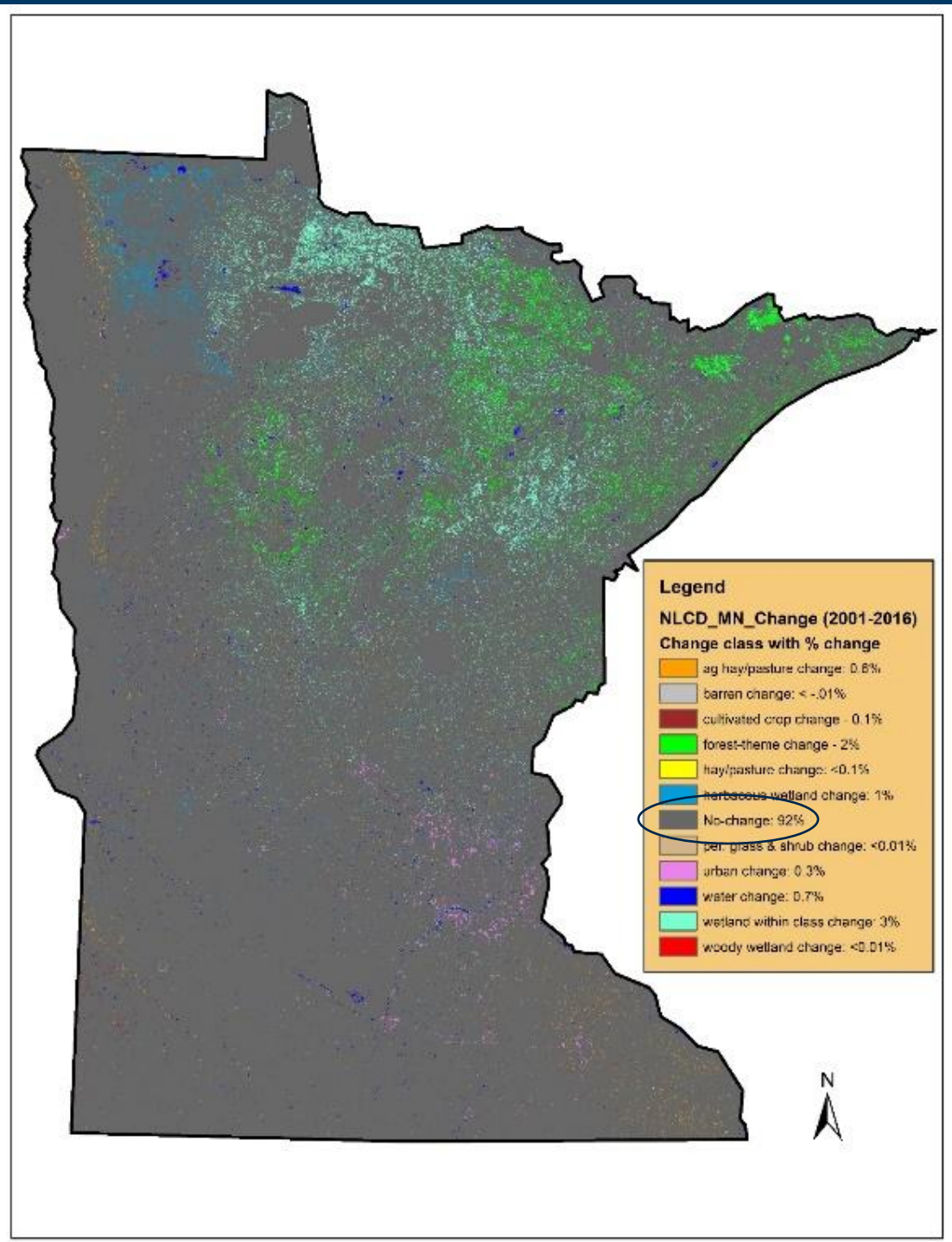
Land use changes

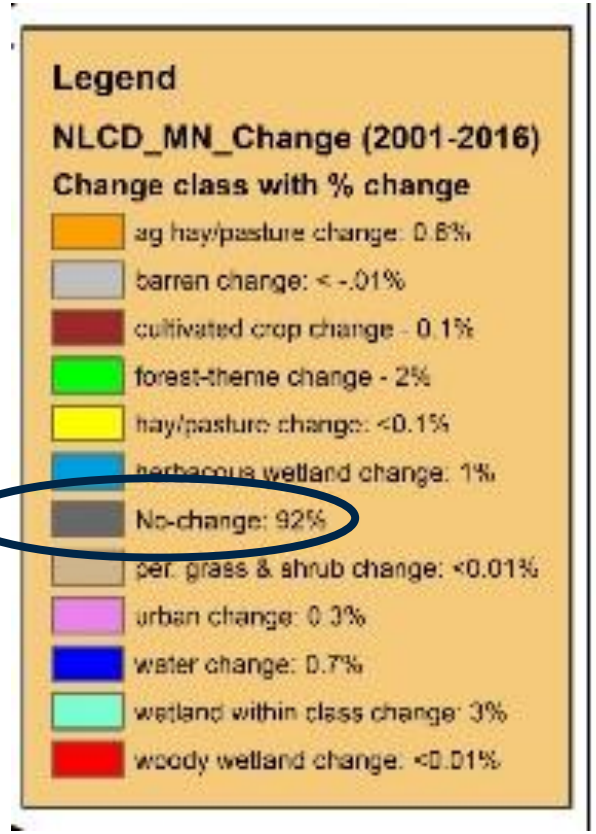




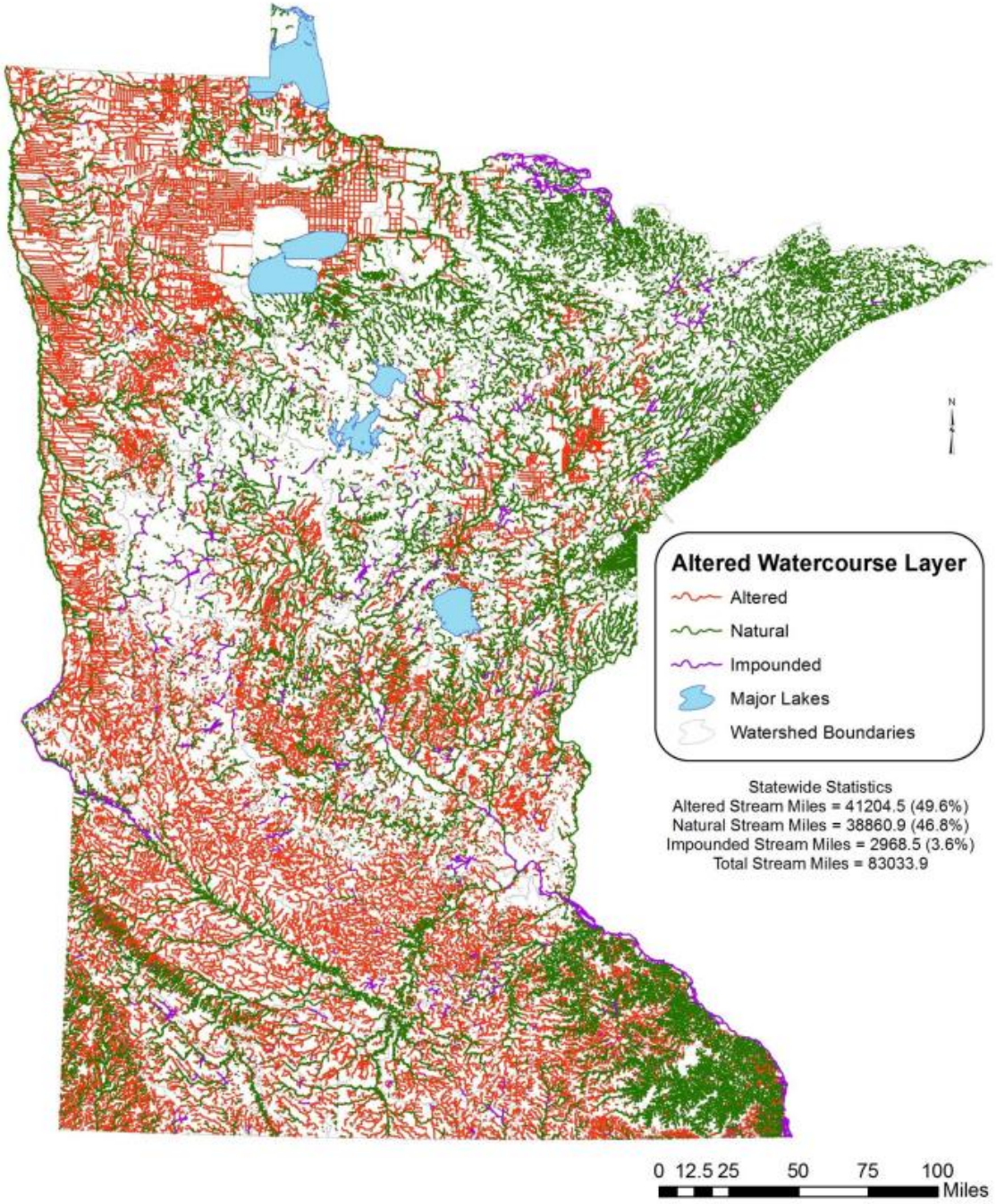
Perspective

Change in land use 2001-2016 NLCD



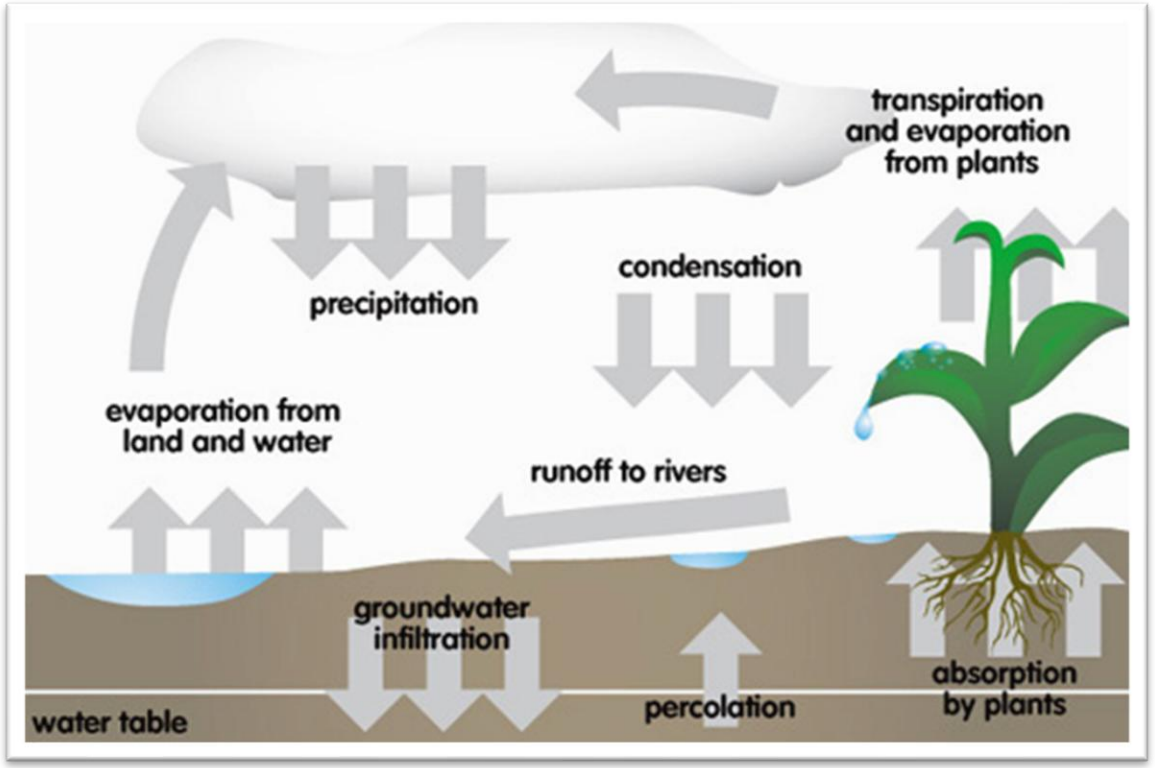


Landscape Alterations

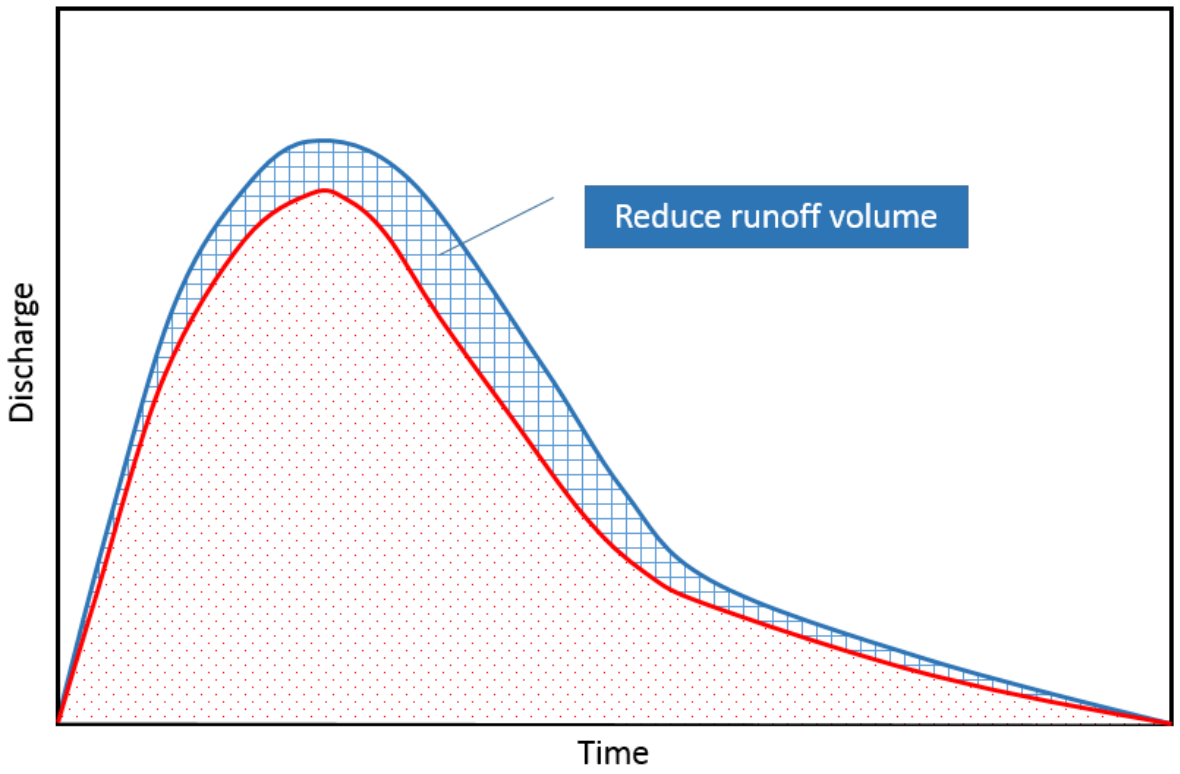


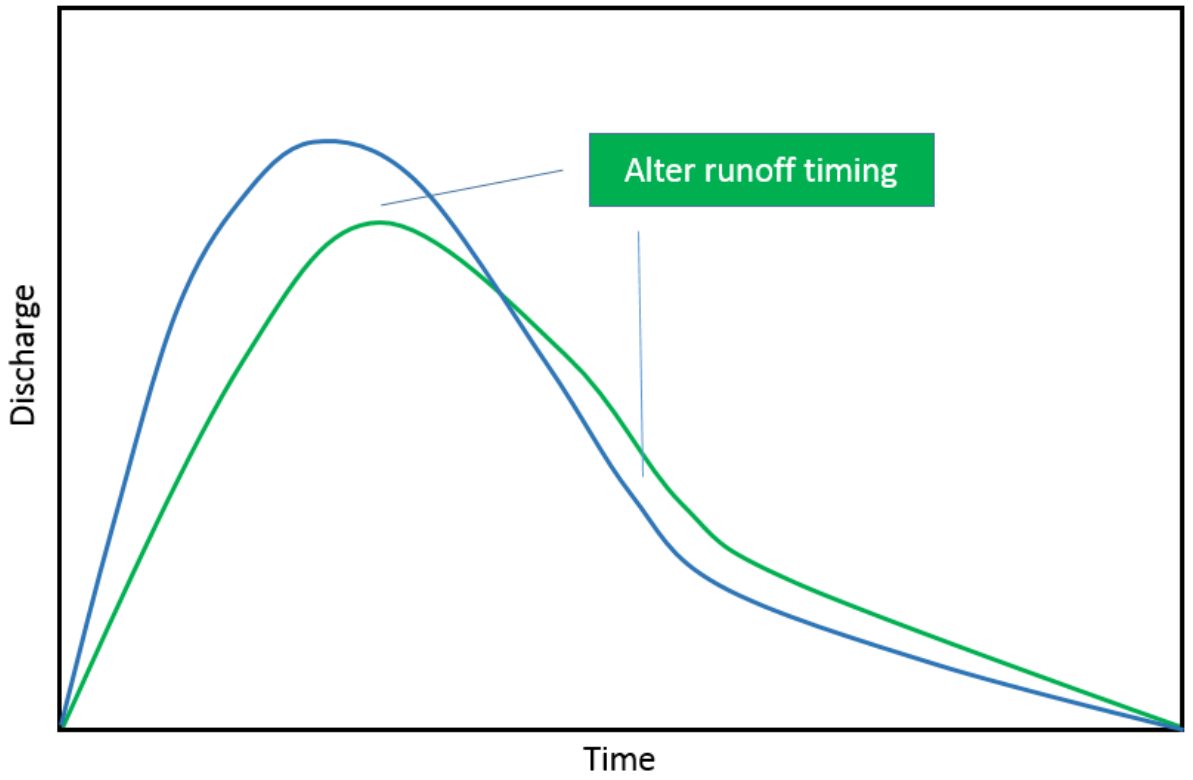
How do we fix this?

- Increase Evapotranspiration
- Increase Temporary Water Storage



Changes to hydrographs - volume versus timing





Practices to consider - 1

	Increase ET	Increase soil water holding capacity	Increased short-term surface storage (detention)	Increased long-term surface storage (retention)
Crop and Soil Management				
Cover Crops (340)	x	x		
Conservation Cover (327)	x	x		
Conservation Crop Rotation (328)	x	x		
Conservation Tillage (329, 345 and 346)	x	x		
Contour Farming (330)	x	x	x	
Field Borders (386)	x	x		
Forage and Biomass Plantings (512)	x	x		
Manure Application		x		
Land use change to perennial cover	x	x	x	
In-field Drainage Water Management				
Controlled drainage (DWM 554)	x		x	
Alternative Tile Inlets			x	
Alternative drainage design			x	

Practices to consider - 2

Practice Type	Increase ET	Increase soil water holding capacity	Increased short-term surface storage (detention)	Increased long-term surface storage (retention)
Water Storage & Infiltration Saturated buffers ()	x	x		
Small Impoundments (356-dike)			x	x
Large Impoundments (356-dike)			x	x
Constructed Wetland (656)	x		x	x
Wetland Restoration (657)	x		x	x
Ponds (378)			x	x
Water and Sediment Control Basins (638)			x	
Terrace (600)			x	

Practices to consider - 3

Practice Type	Increase ET	Increase soil water holding capacity	Increased short-term surface storage (detention)	Increased long-term surface storage (retention)
In-Channel Water Retention Two-staged ditch (with culverts sized to offset increased conveyance capacity if needed)			x	
Protection/management of existing ditches with two-stage channel			x	
Design standards for surface drainage that reduce flood peaks			x	
Restricted culvert sizing			x	
Ditch Plugging and/or abandonment			x	
Grade stabilization			x	
Setting back existing levees			x	
Impoundments			x	x

Considerations for multipurpose water storage implementation

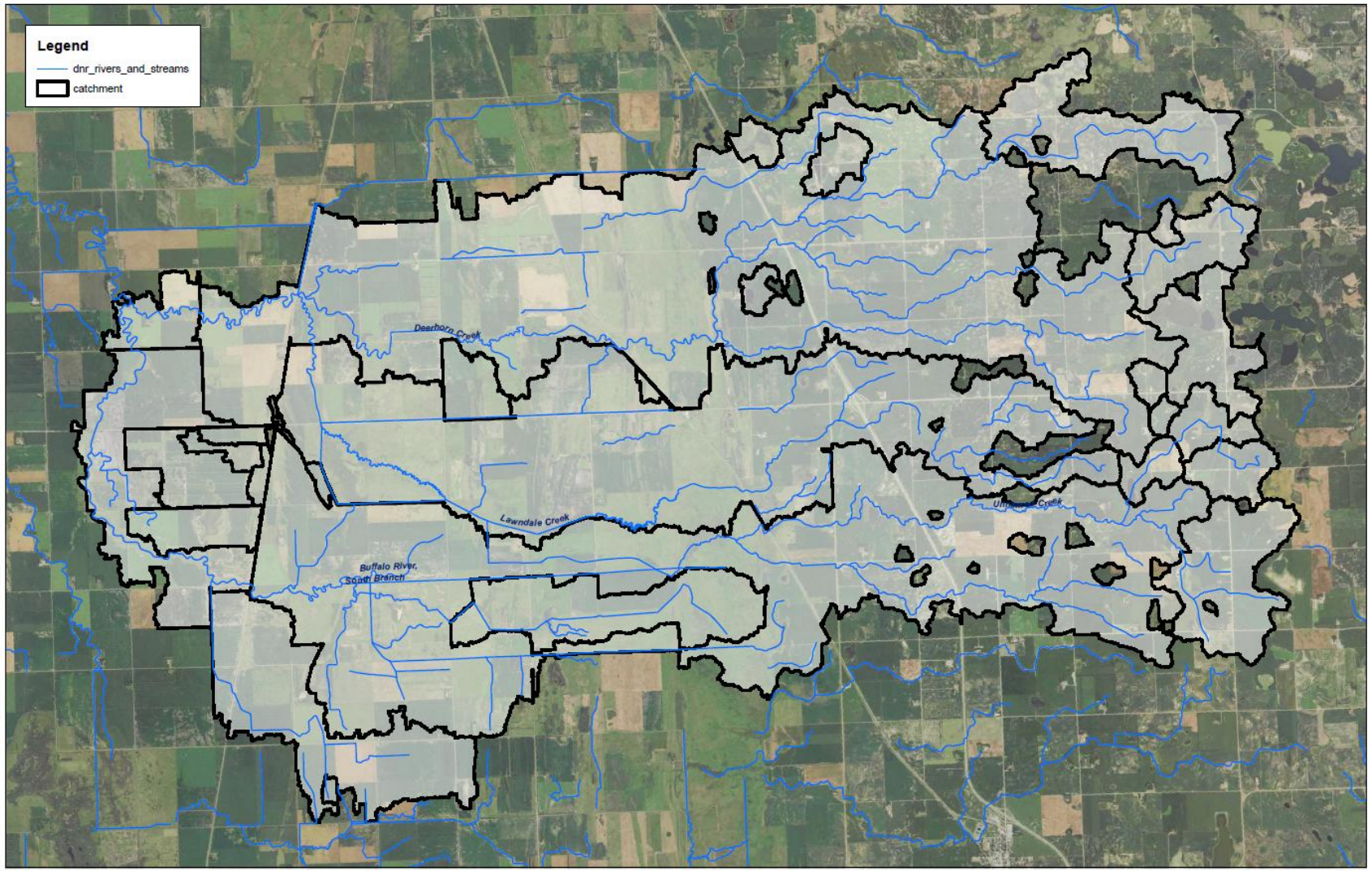
- Where can a strategy/action be applied?
- Where are they most effective to achieve hydrology goals?
- Where are they least effective…?
- What are the potential conflicts AND MULTIPURPOSE BENEFITS in relation to other resource goals?
  - E.g. Habitat and water quality

Test watershed:

Upper reaches of South Branch Buffalo River

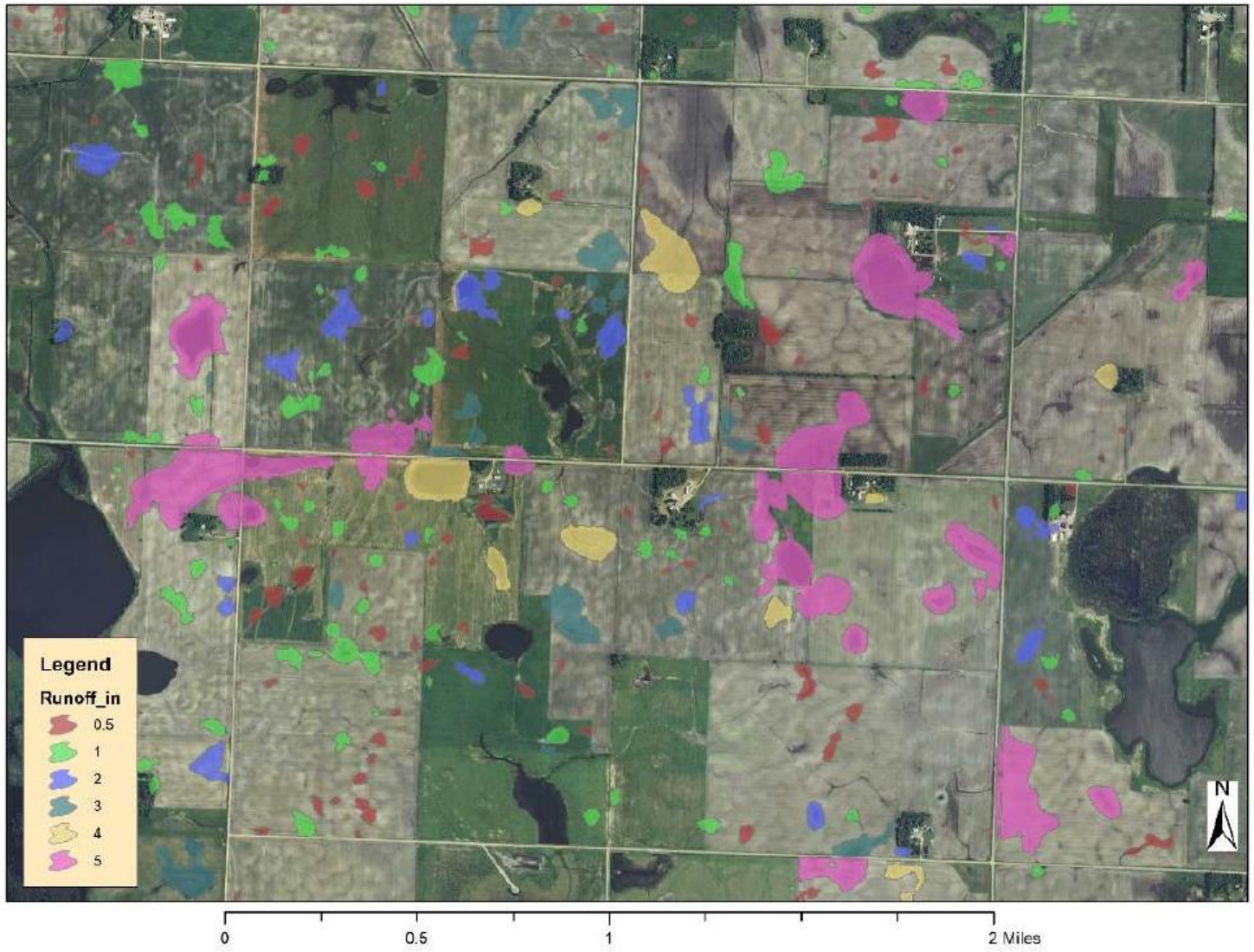
~88 sq. miles

Includes beach ridge to valley floor topography.

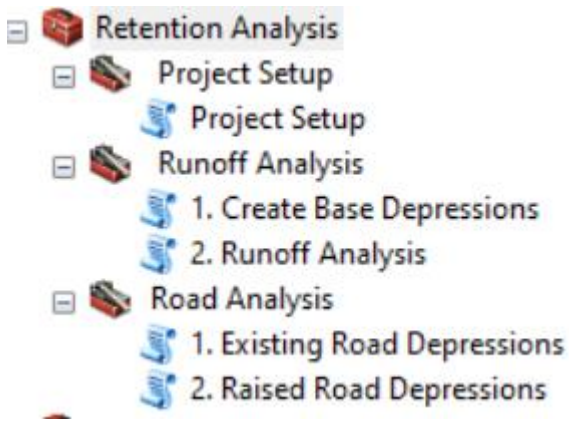


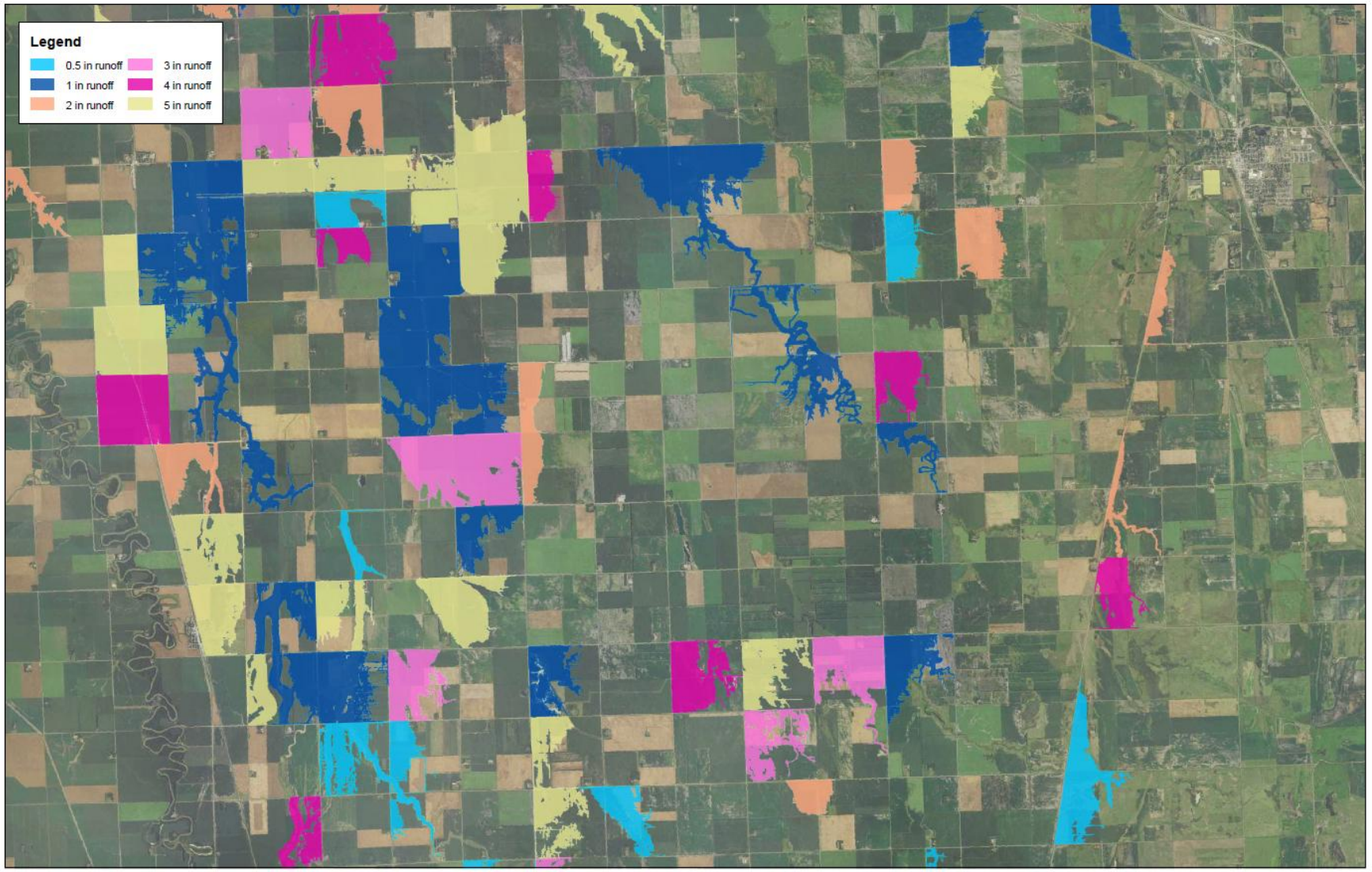
Existing Tools and Resources (Existing and Drained Depression Evaluation)

- Drained Wetland Oct18 10p3
  - 1 - Remove Roads
  - 2 - Smooth Ditches
  - 3 - CTI
  - 4 - Filter CTI
  - 5 - CTI Plugs
  - 6 - RWI Plugs (depending on availability)
  - 7a - Plug Hydro with RWI
  - 7b - Plug Hydro without RWI
  - 8 - Depth Grid
  - Classify Roads
  - depthgrid_to_polygon
  - Filter_depthgrid
  - filter_dg_polygon

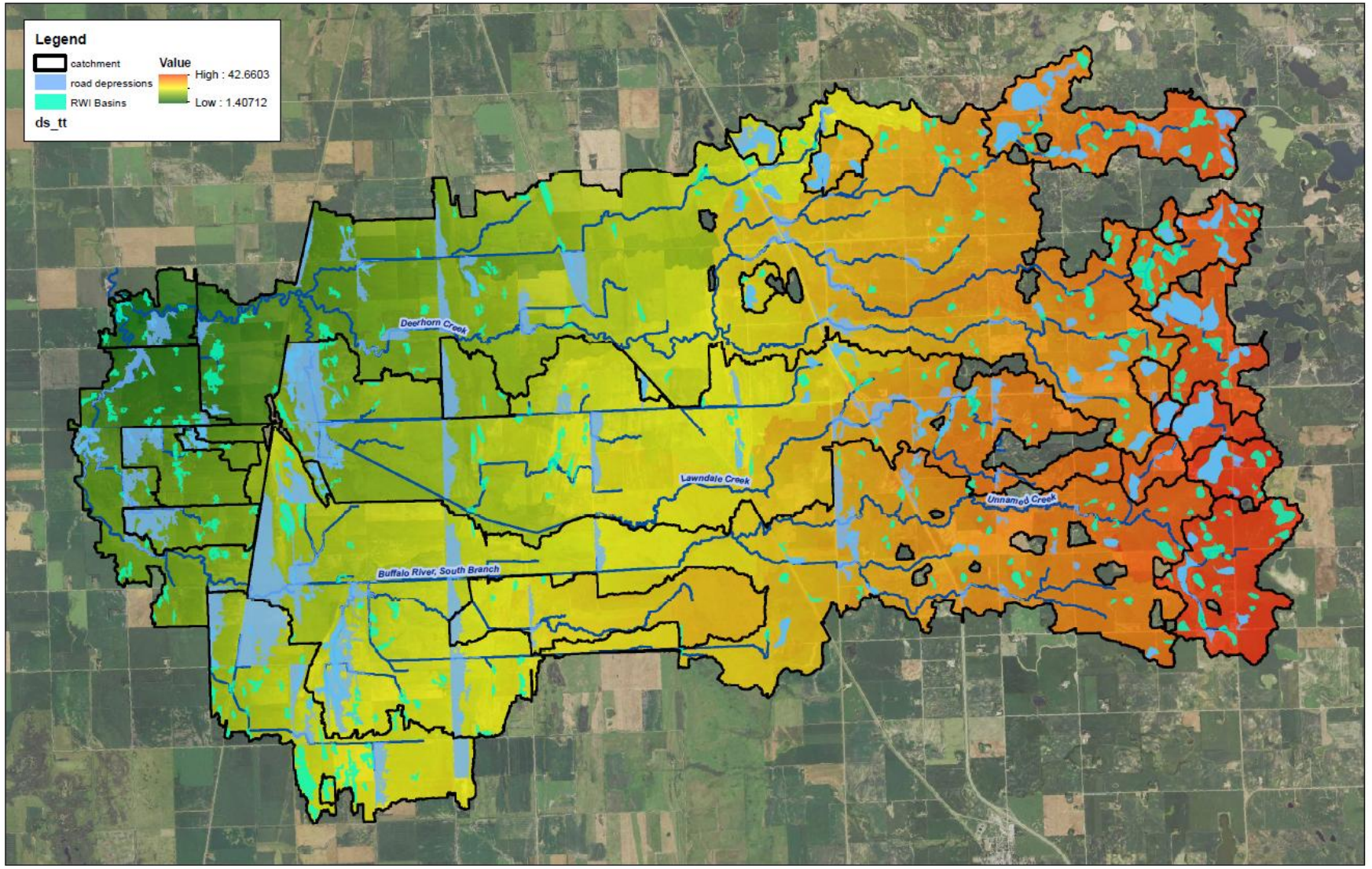


Existing Tools and Resources
Retention Tools

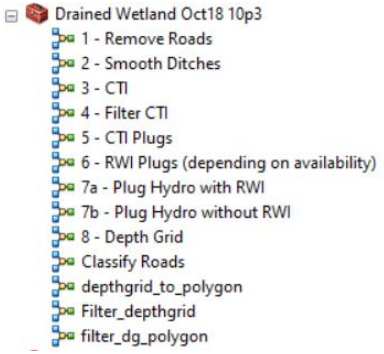


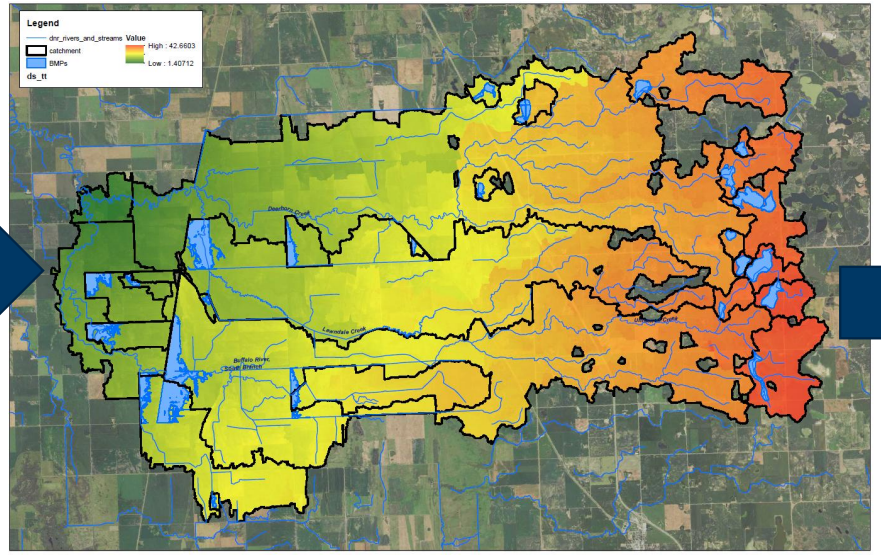


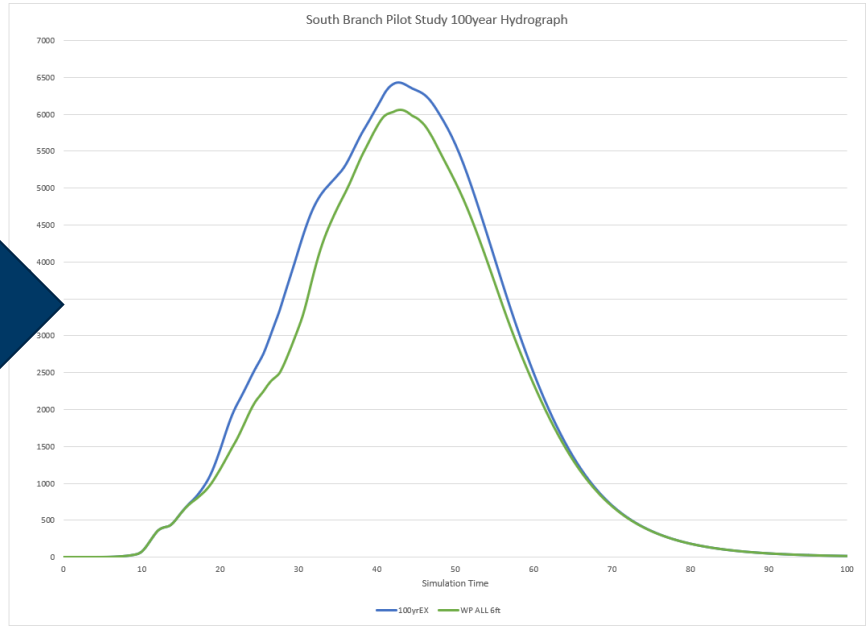
South Branch Pilot Study Area
Travel Time and Potential Sites



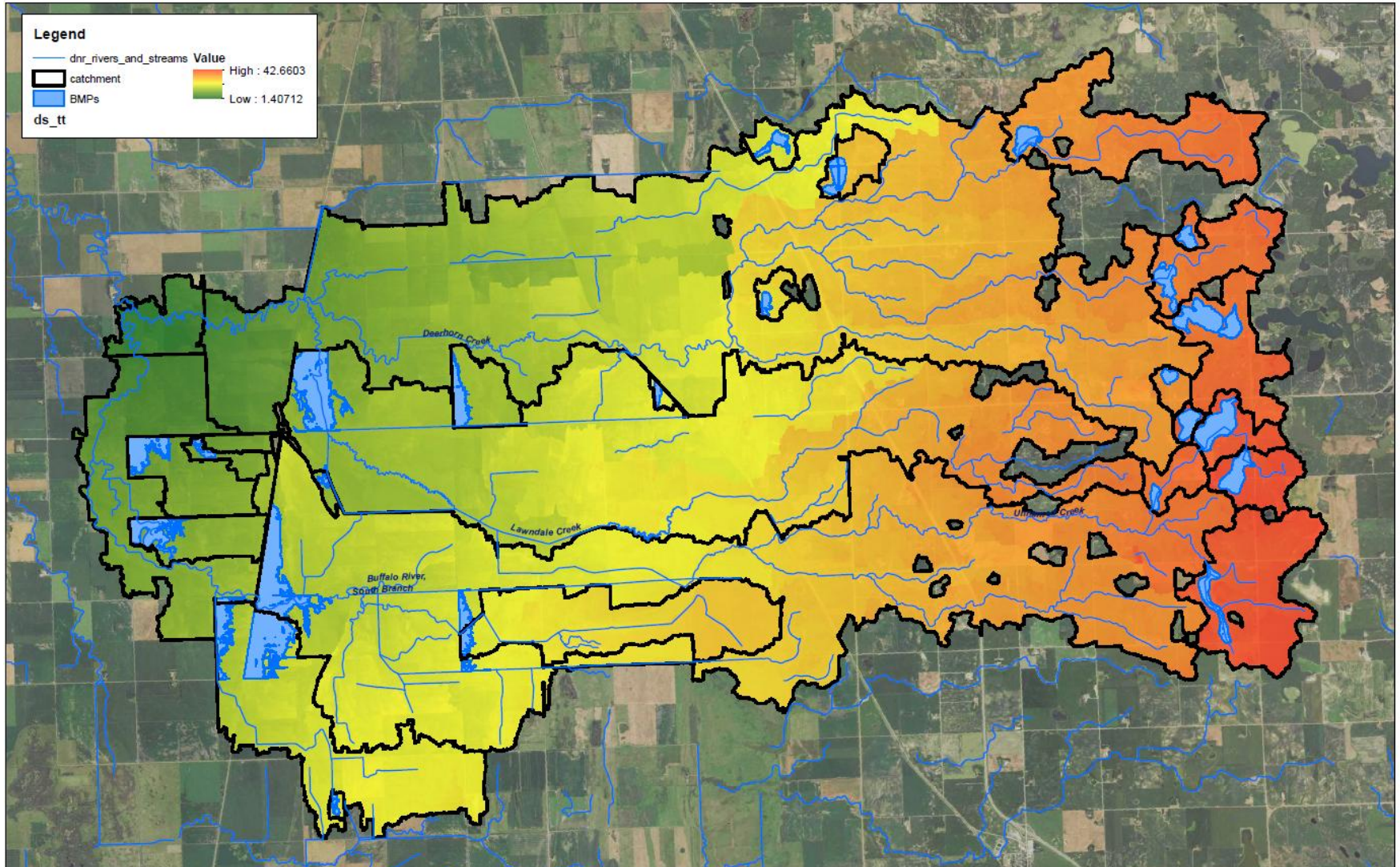
Connecting these tools to create BMP storage site options and their impact on the peak discharge hydrograph



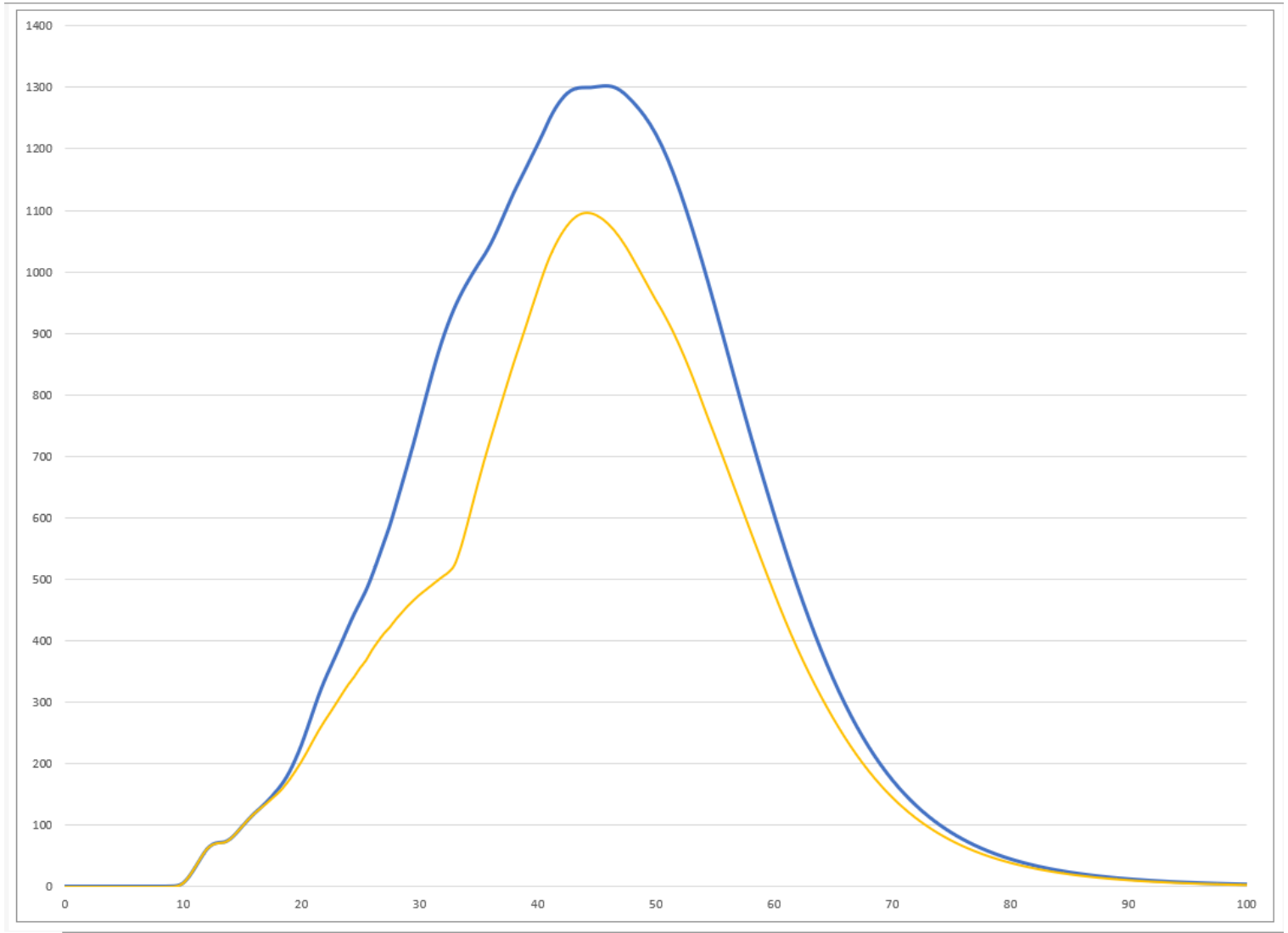




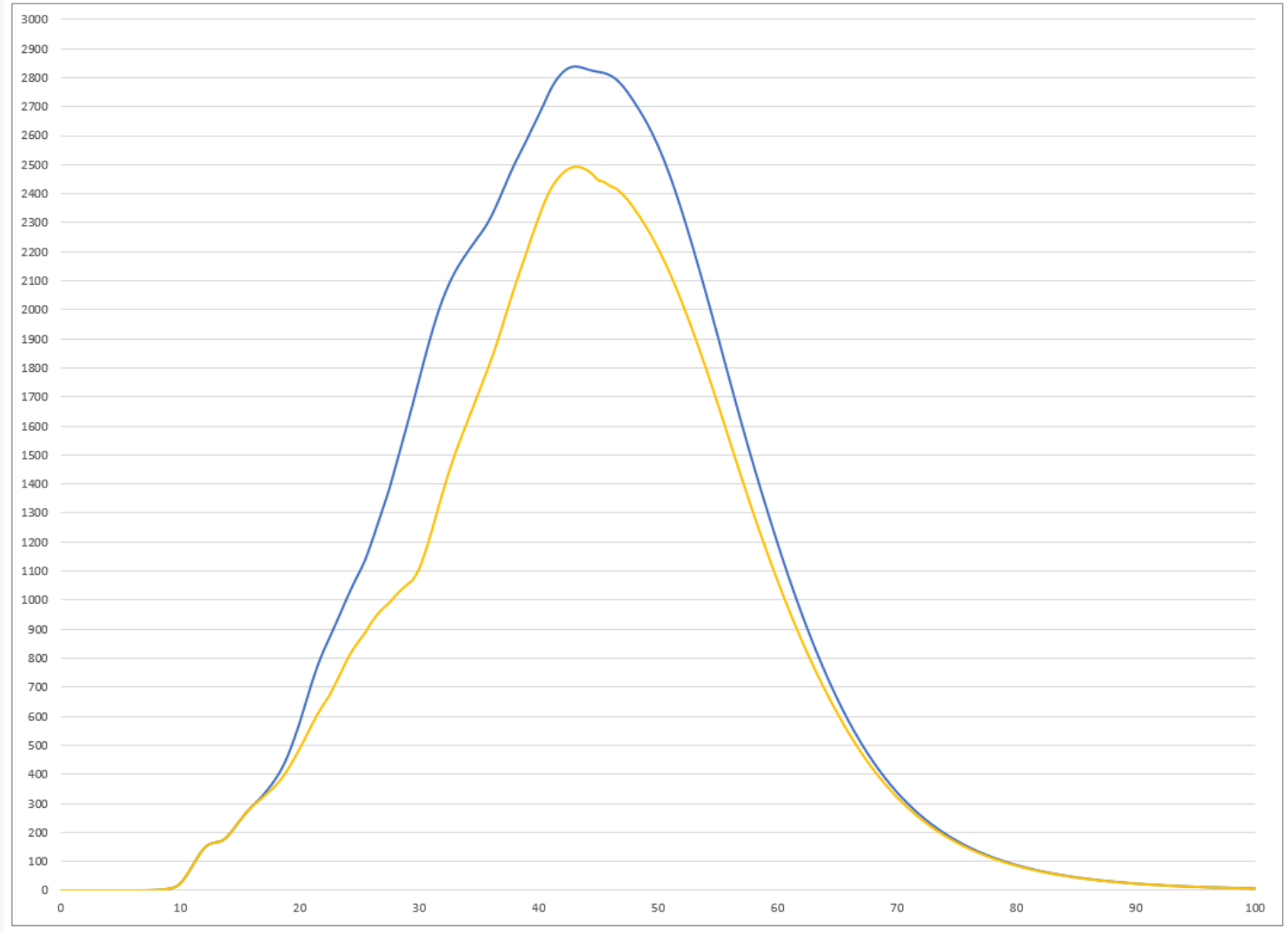
South Branch Pilot Study Area
Travel Time and Test Sites



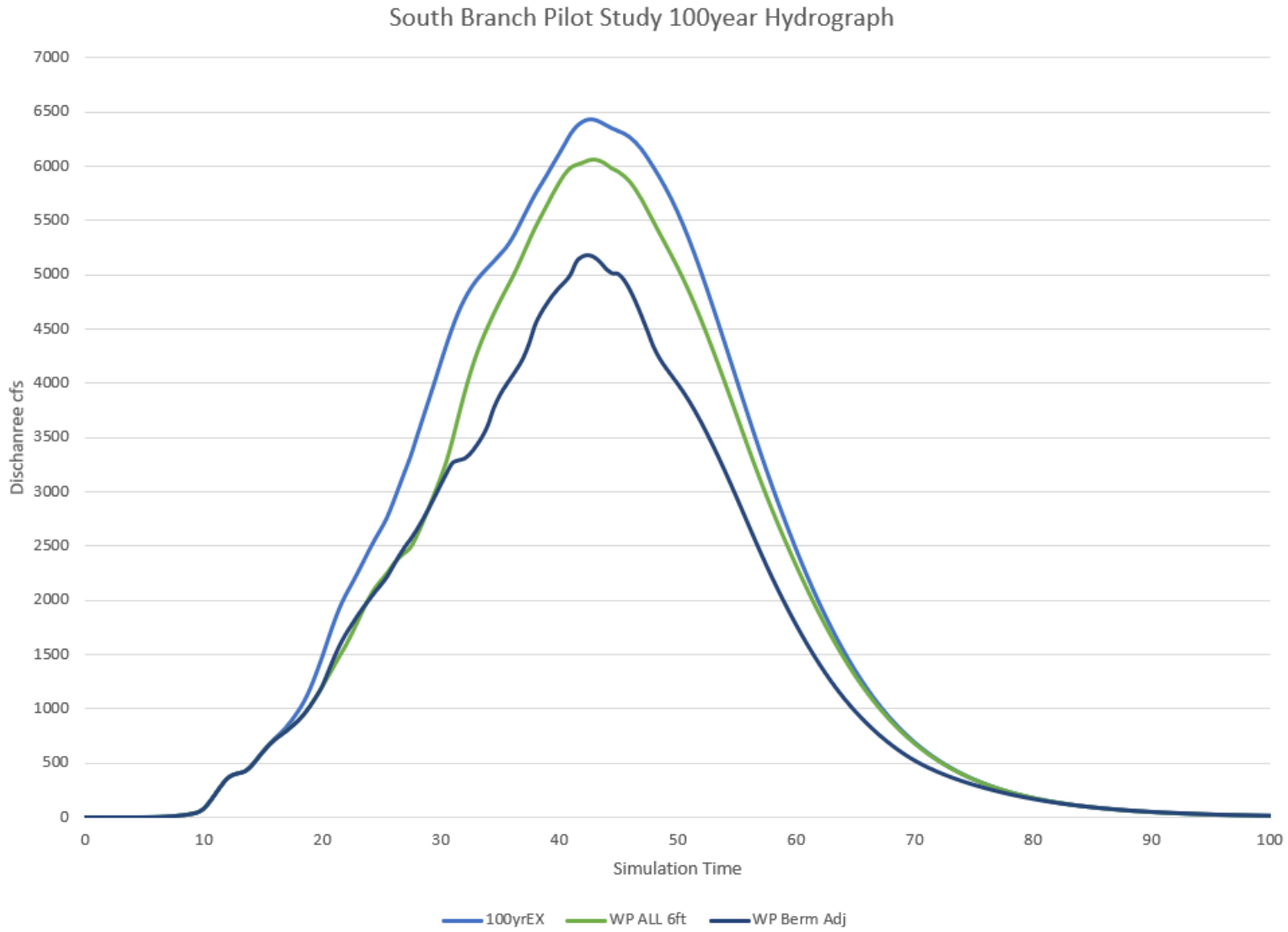
South Branch Pilot Study Area
Existing & With All storage sites 2Year



South Branch Pilot Study Area
Existing & With All Sites 10Year



South Branch Pilot Study Area
Existing & All Sites 100Yr w/embankment height adjustments

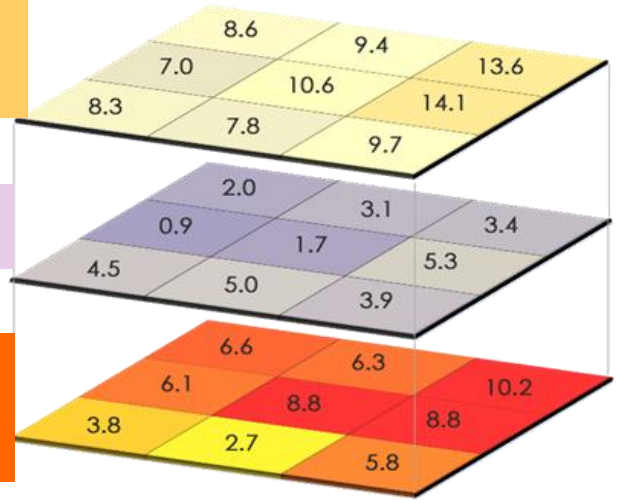


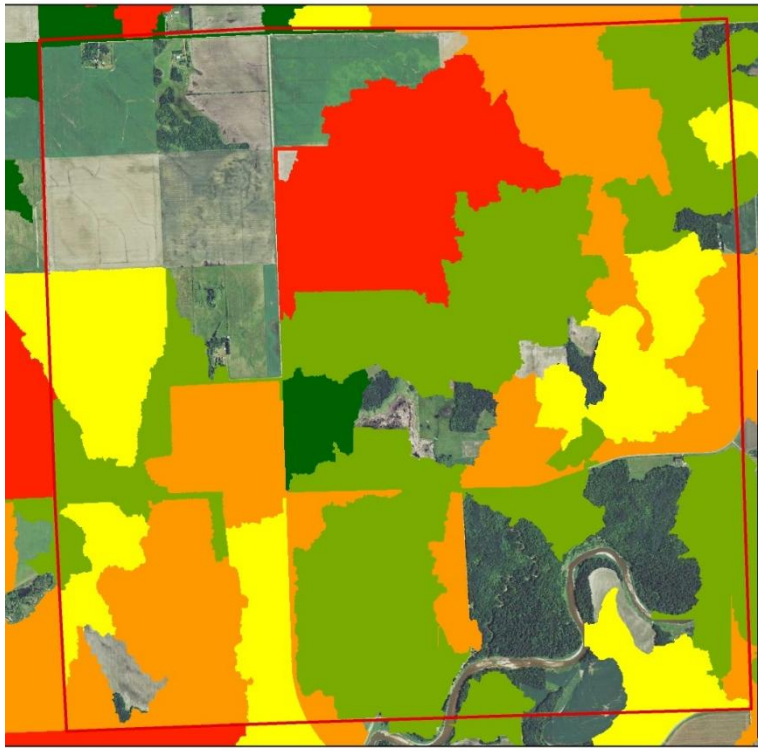
Striving for multipurpose benefits based on priorities

Peak flow/runoff priorities

Habitat priorities

Sediment load priorities





Next Steps

- Work in three demonstration watersheds to develop data and framework to guide local watershed groups to develop a watershed storage strategy to achieve hydrology goals.
- Refine data / models / process based on lessons learned in demonstration watersheds.
- Package information into guidance for local watersheds to develop and implement water storage strategy.

BOARD OF WATER AND SOIL RESOURCES

Thank You! – Questions?

Henry Van Offelen

henry.van.offelen@state.mn.us

Ryan Hughes

Ryan.hughes@state.mn.us



Factors at the watershed scale – volume and timing

