Current Science of Nutrient Flows and Conservation Actions in Iowa: Guiding Principles

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Guiding Principles

- Reduce nutrient export
- Slow the flow – restore some of the natural hydrology

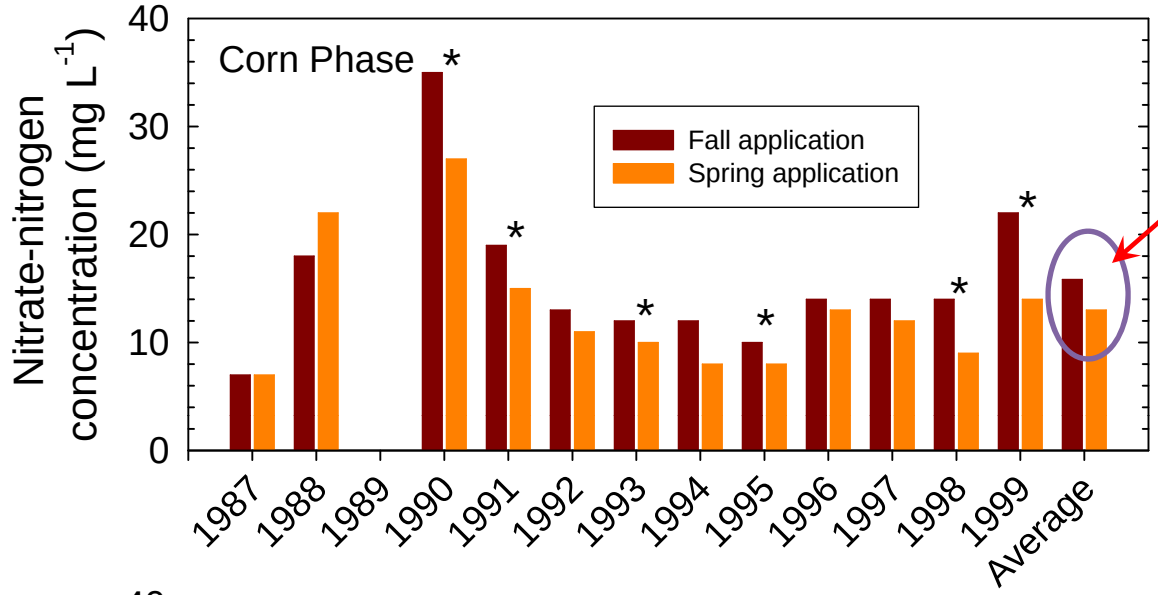
Ways to Achieve This

- Synchronize nutrient supply with nutrient demand
- Increase continuous living cover
- Optimize drainage design and management
- Exploit the interface between land and water

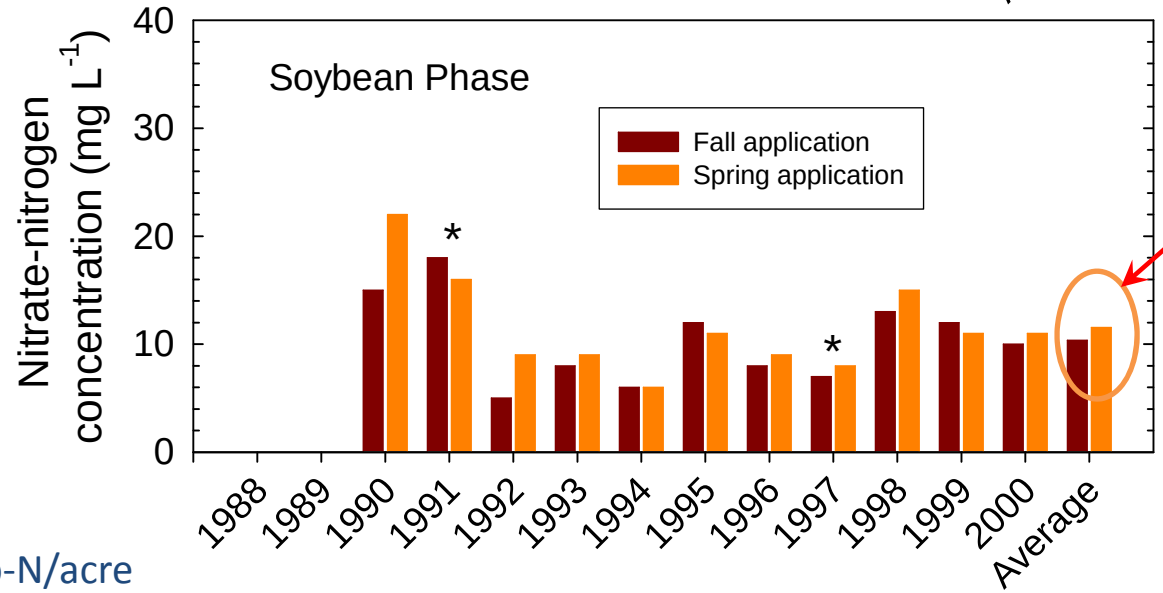
Synchronize Nutrient Supply with Nutrient Needs

- Utilize nutrient management strategies that match nutrient needs of crops both in rate and timing
- Benefits
  - Reduce risk of losses
  - Potentially reduce overall application rates
- Disadvantage
  - Potential management challenges
- Need for better documentation of current conditions

Annual Nitrate Concentrations from Waseca, MN



~21% increase with fall application

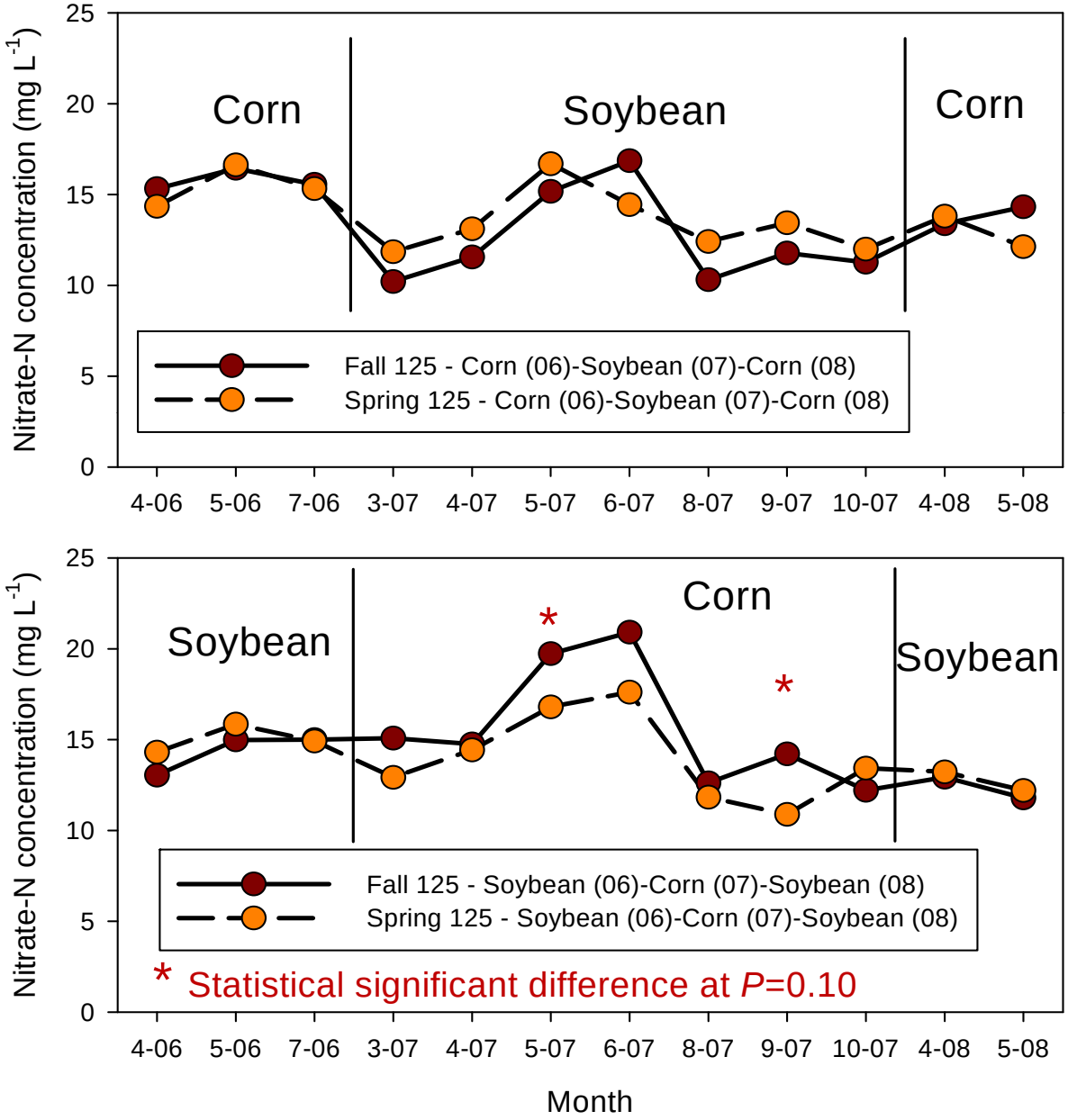


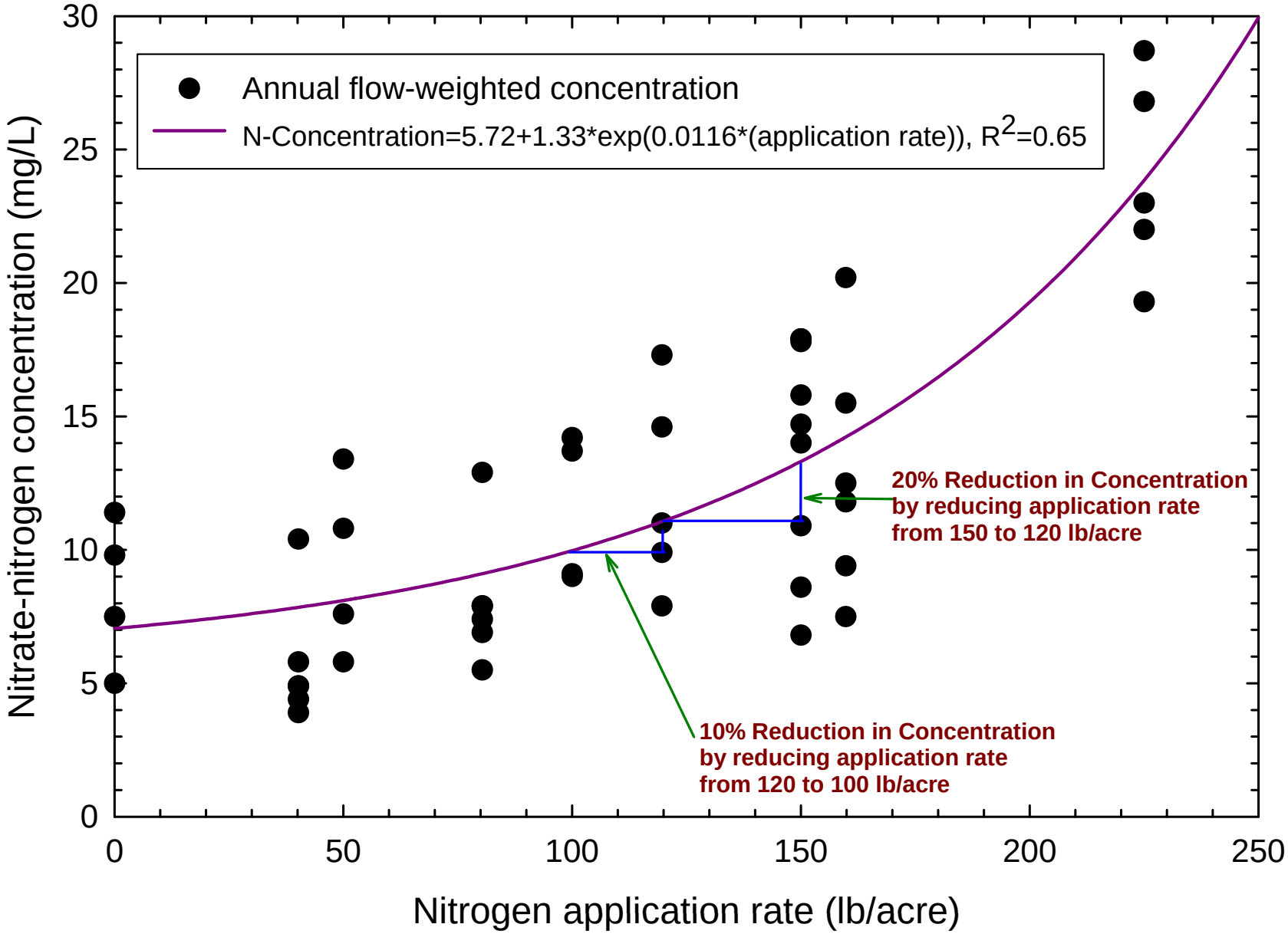
~10% decrease with fall application

1987-94: 135 lb-N/acre
1995-99: 120 lb-N/acre

Randall et al., 2003 and Randall et al., 2005

Monthly Nitrate Concentrations from Gilmore City, IA





Overall Nitrogen Application Rate Effect on Nitrate-Nitrogen Concentration
Corn/Soybean Rotation

Increase Continuous Living Cover

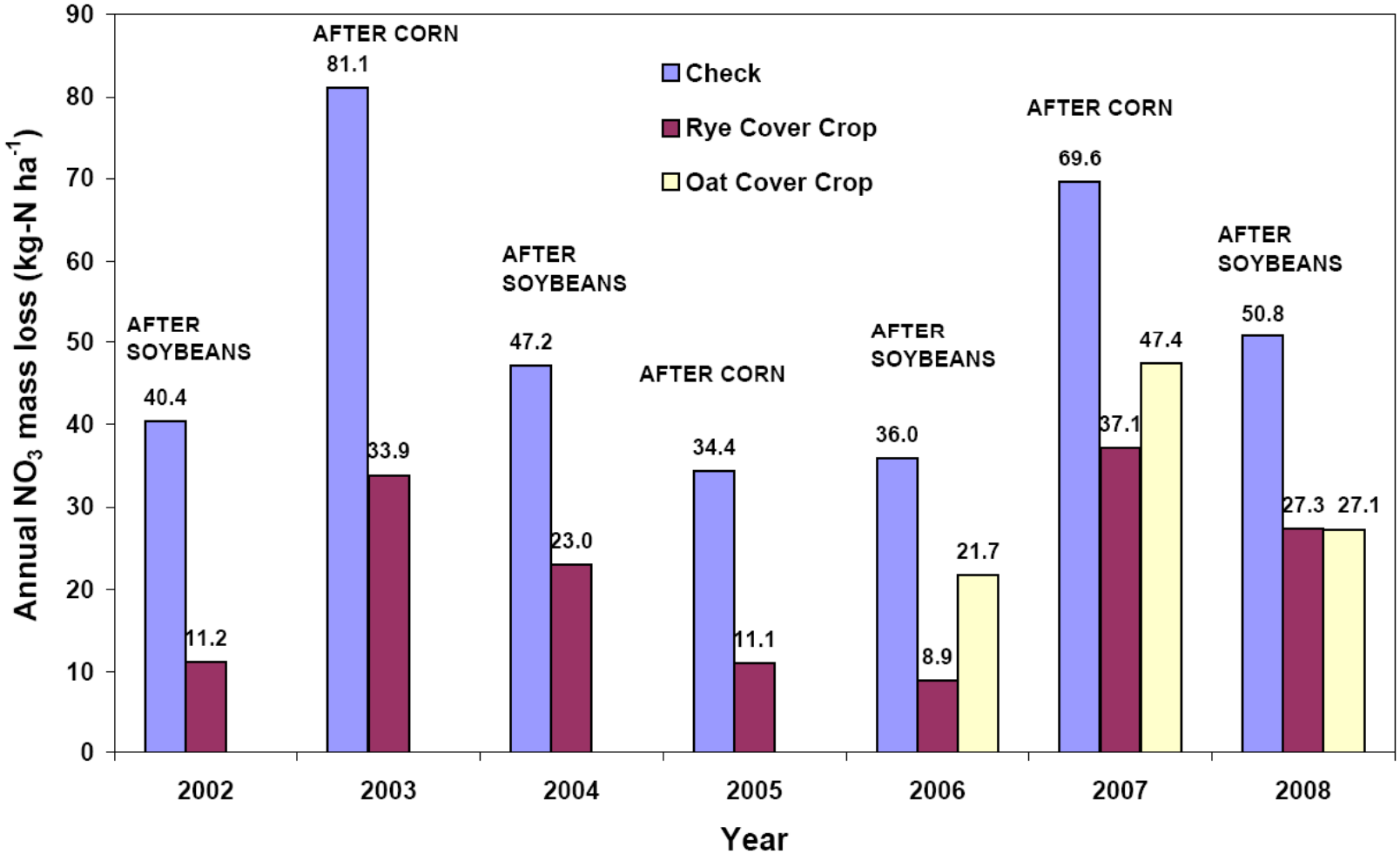
- Utilize cropping systems that protect soil surface and reduce risk of leaching losses
- Benefits
  - Reduced soil erosion and losses of contaminants associated with surface runoff
  - Recycle soil nutrients and reduce risk of nutrient losses (e.g. loss of nitrates through drainage systems)
  - Provide soil quality benefits
  - Increased water use during susceptible periods

Increase Continuous Living Cover

- Disadvantage
  - Potential management challenges
  - Increased cost and potential impacts on yield
  - Perennial land uses may result in reduced downstream water flow
- Need for further documentation of practice performance, management recommendations, and further review of suitable cultivars and species


KELLY PLOT 13 SOY/RYE CC 4-16-04
APR 16 2004

Annual N Loss in Tile Drainage for a Corn-Soybean Rotation with or without a Winter Cover Crop



United States Department of Agriculture

Agricultural Research Service

National Soil Tilth Laboratory
Creating Agricultural Success

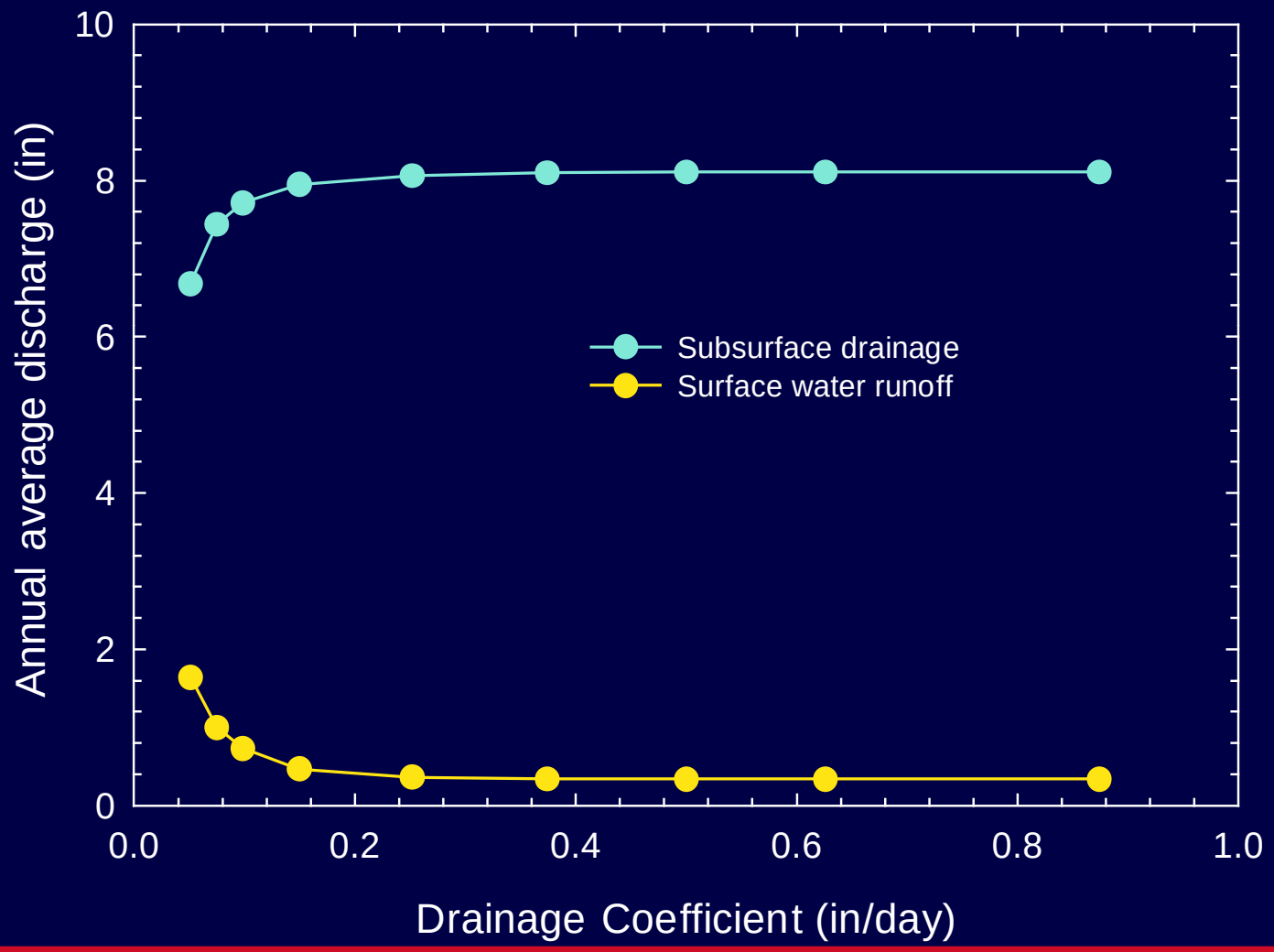
Optimize Drainage Design and Management

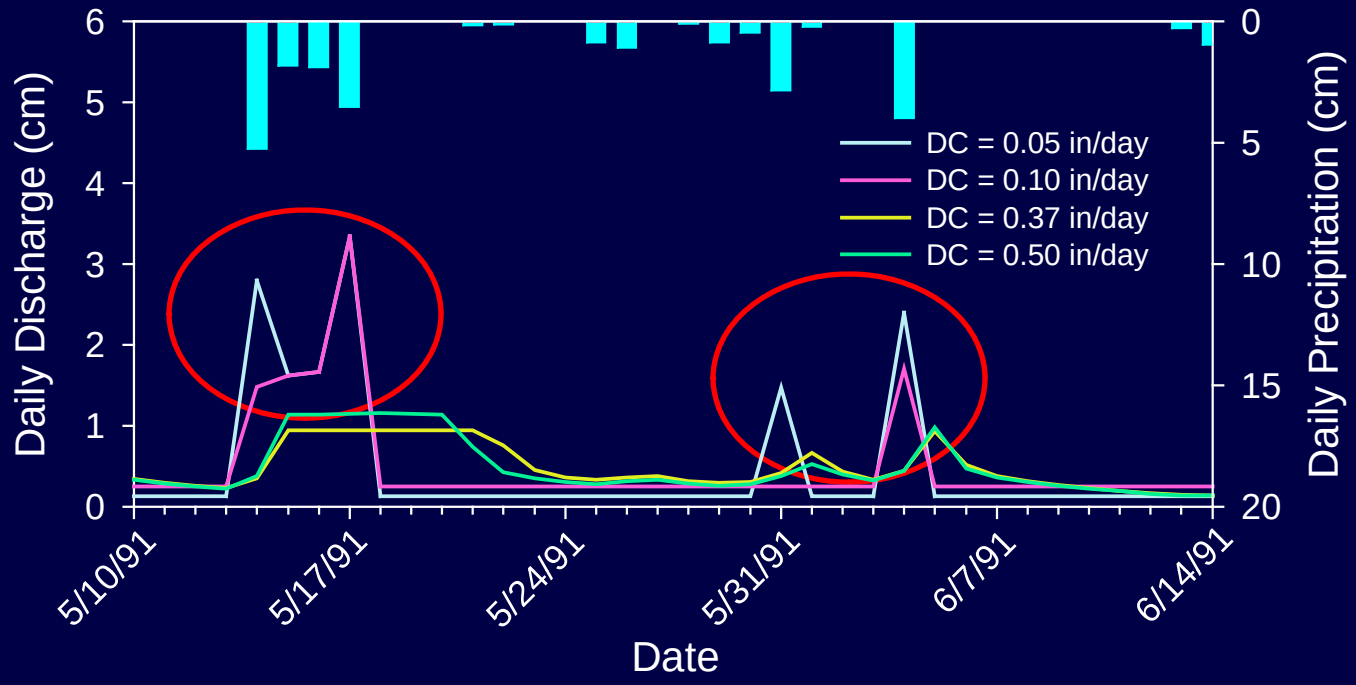
- Consider impacts of drainage design and management on contaminant transport and hydrology
- Drainage can impact both surface runoff and subsurface drainage
- Balance surface runoff and subsurface drainage implications

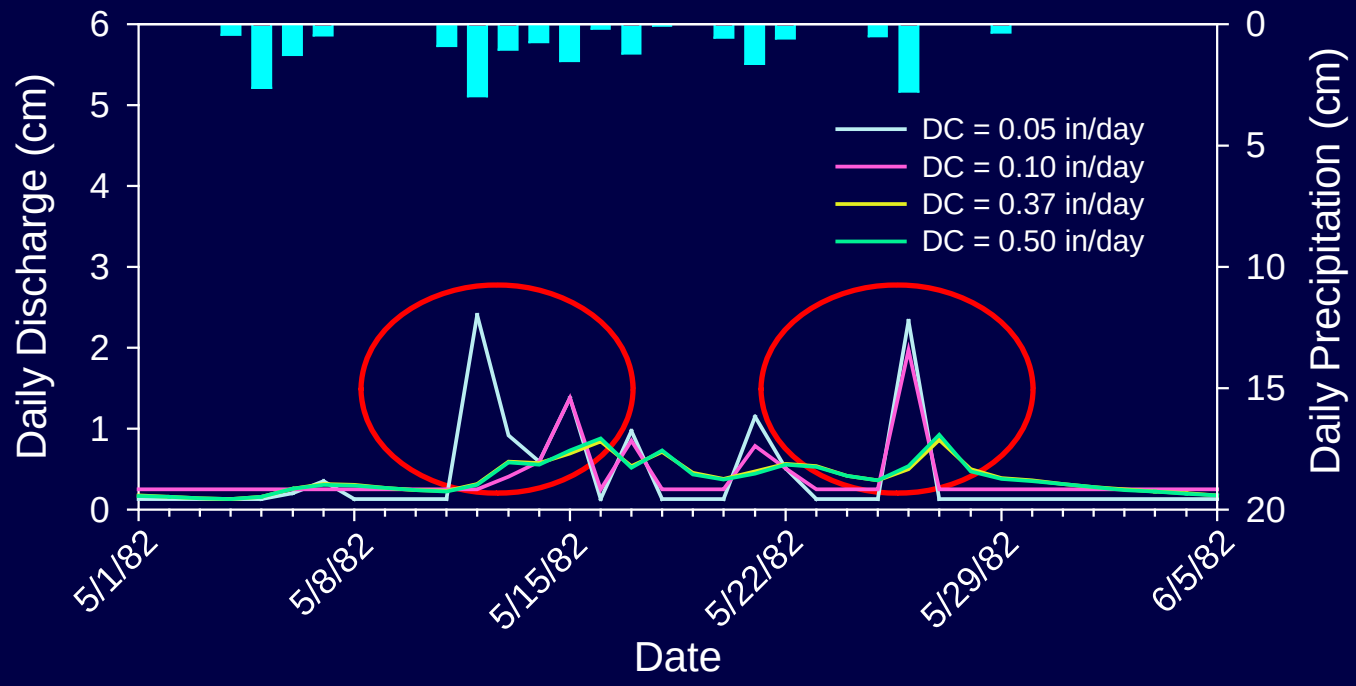
Drainage Design

- To protect crops, the subsurface drainage system must be able to remove excess water from the active root zone within 24 to 48 hours after a heavy rain
- Drainage coefficient is the depth of water to be removed from the drainage area in 24 hours
- Modern drainage systems would be designed with a drainage coefficient of 0.5-1.0 in/day
- From surveys performed in 1980's many drainage systems have a drainage coefficient of <0.25 in/day (some <0.10 in/day)

Impacts of Drainage Design

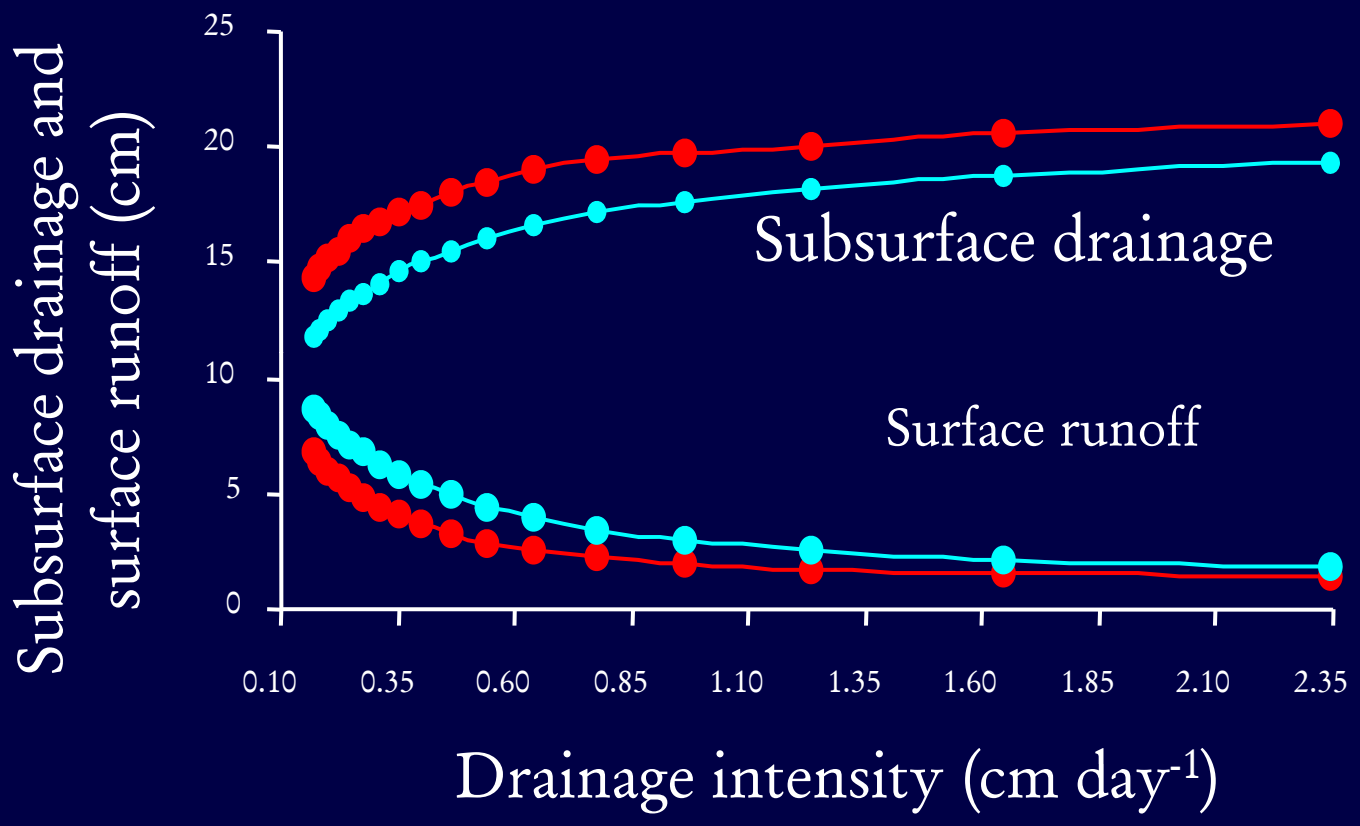






Impacts of Drainage Design on Daily Discharges

Impacts of Controlled Drainage



Impact of Controlled drainage (to maintain water table depth at 60cm) on average relative yields, subsurface drainage and surface runoff of WEBS_CC tile landscape simulated over the 60 years (1945-2004) .

Exploit the Interface Between Land and Water

- Benefits
  - Prevent off-site transport of contaminants
  - Treat water before entering downstream waterbodies
  - Maximize efficiency of practices
  - Protect areas from future degradation
- Disadvantage
  - May take some land out of production

Examples

- Incorporate systems that provide protection or treatment of water at the land-water interface
- Practices
  - Tillage
  - Vegetative systems
  - Water storage features (e.g., terraces)
  - Stabilization of streams
  - Wetlands
  - Riparian buffers

Various Buffer/Vegetative Systems

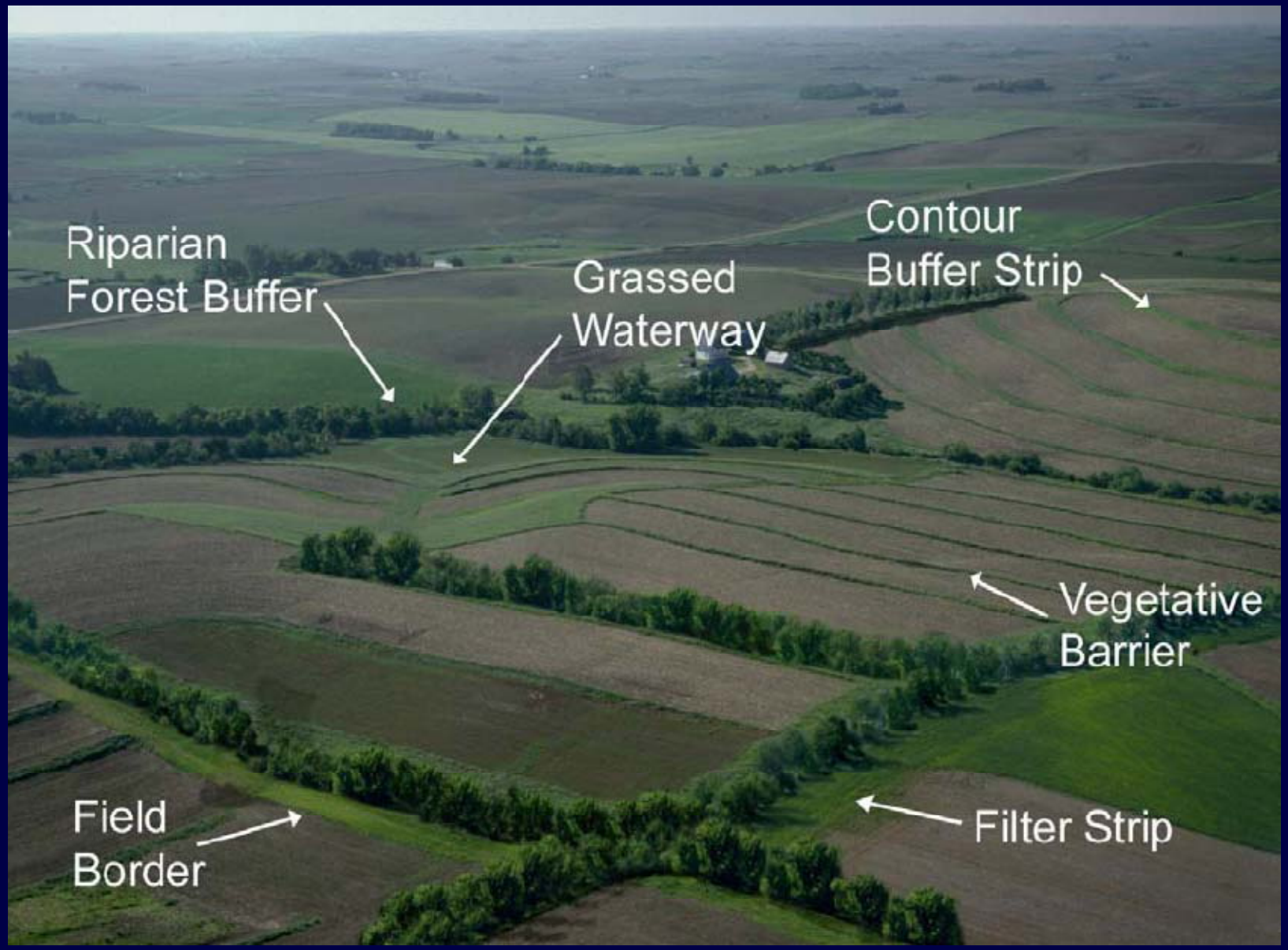


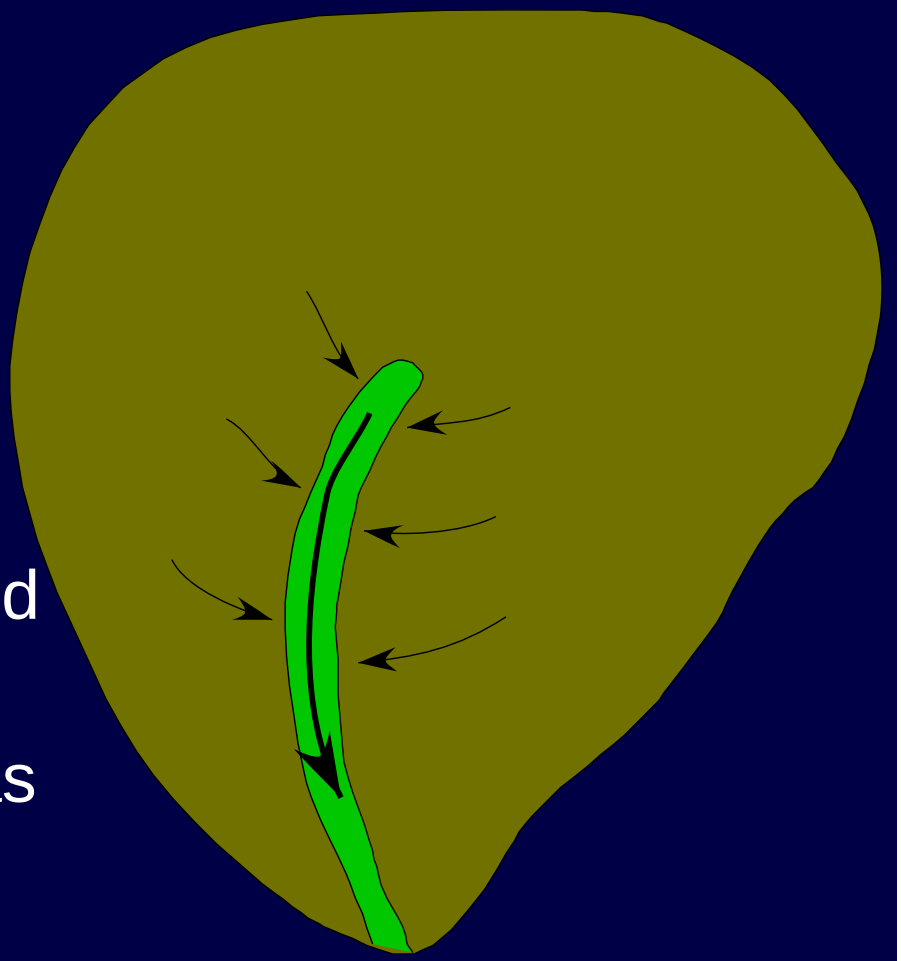
Photo Courtesy of USDA-NRCS

Performance for Buffer Systems with Unsubmerged Flow Conditions

- Surface runoff where unsubmerged flow conditions occur:
  - Sediment trapping efficiency – 41 to 100%
  - Infiltration efficiency – 9 to100%
  - Total phosphorus trapping efficiency – 27 to 96%
  - Nitrate-nitrogen trapping efficiency – 7 to 100%
- Treatment of subsurface flow minimal where primary transport to stream is through drainage systems

Grassed Waterway Performance

- Do they improve water quality?
- Reduced gulley erosion: USDA (1996) reports that based on recent studies in 19 states, ephemeral gully erosion as a percentage of sheet and rill erosion ranged from 21% to 275%.
- Deposition of particulates as water enters edge of grassed waterways



Downstream Considerations

- Even if field-to-stream transport of contaminants are reduced in-stream sources may contribute significant loading to downstream waterbodies

Sediment Source Tracking Using Naturally Occurring Radionuclides (^{7}Be and ^{210}Pb) as Tracers

24%

76%

Slide courtesy of Dr. Tom Isenhart

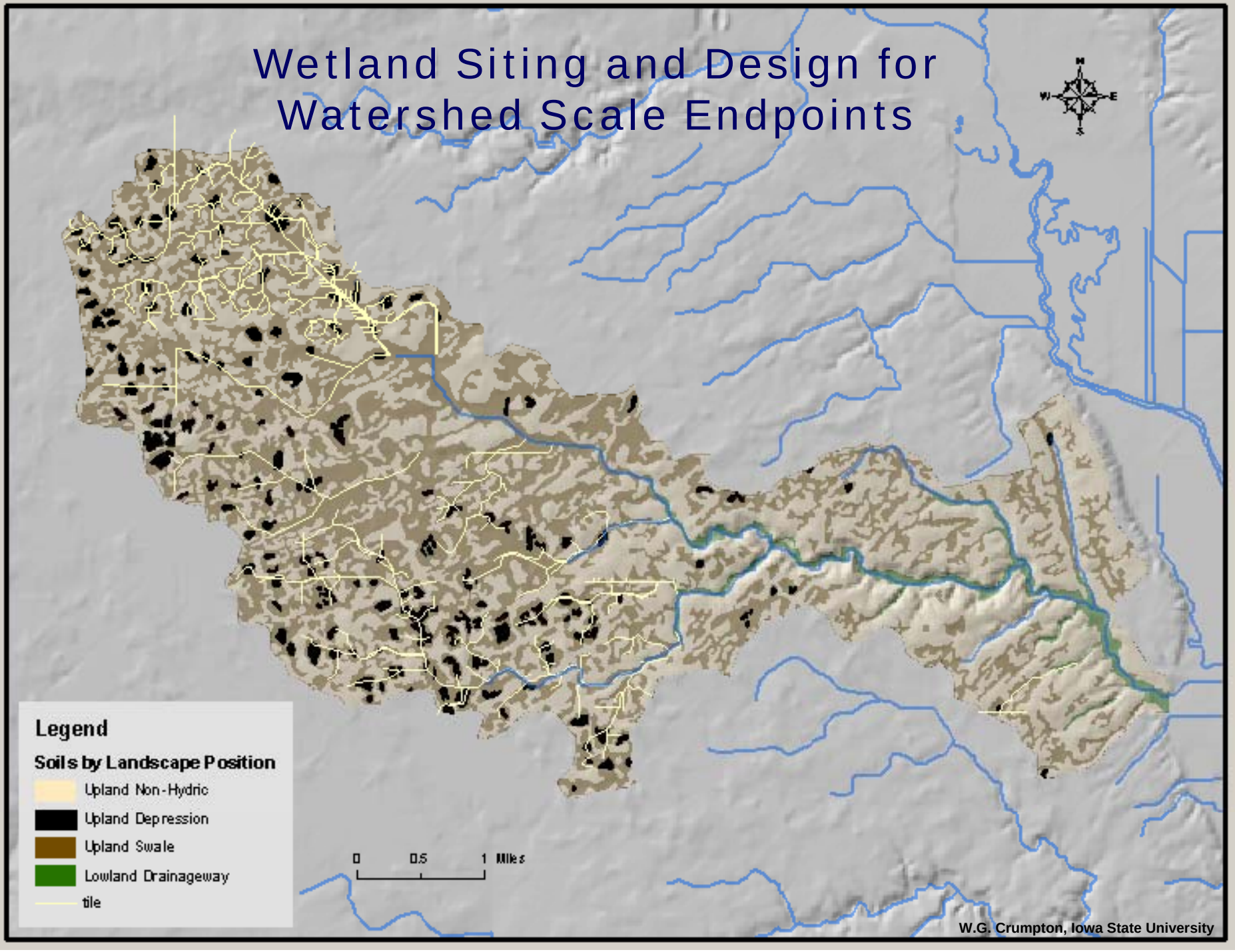
Stream Bank Stabilization

Slide courtesy of Dr. Tom Isenhart

Nitrate Removal Wetlands

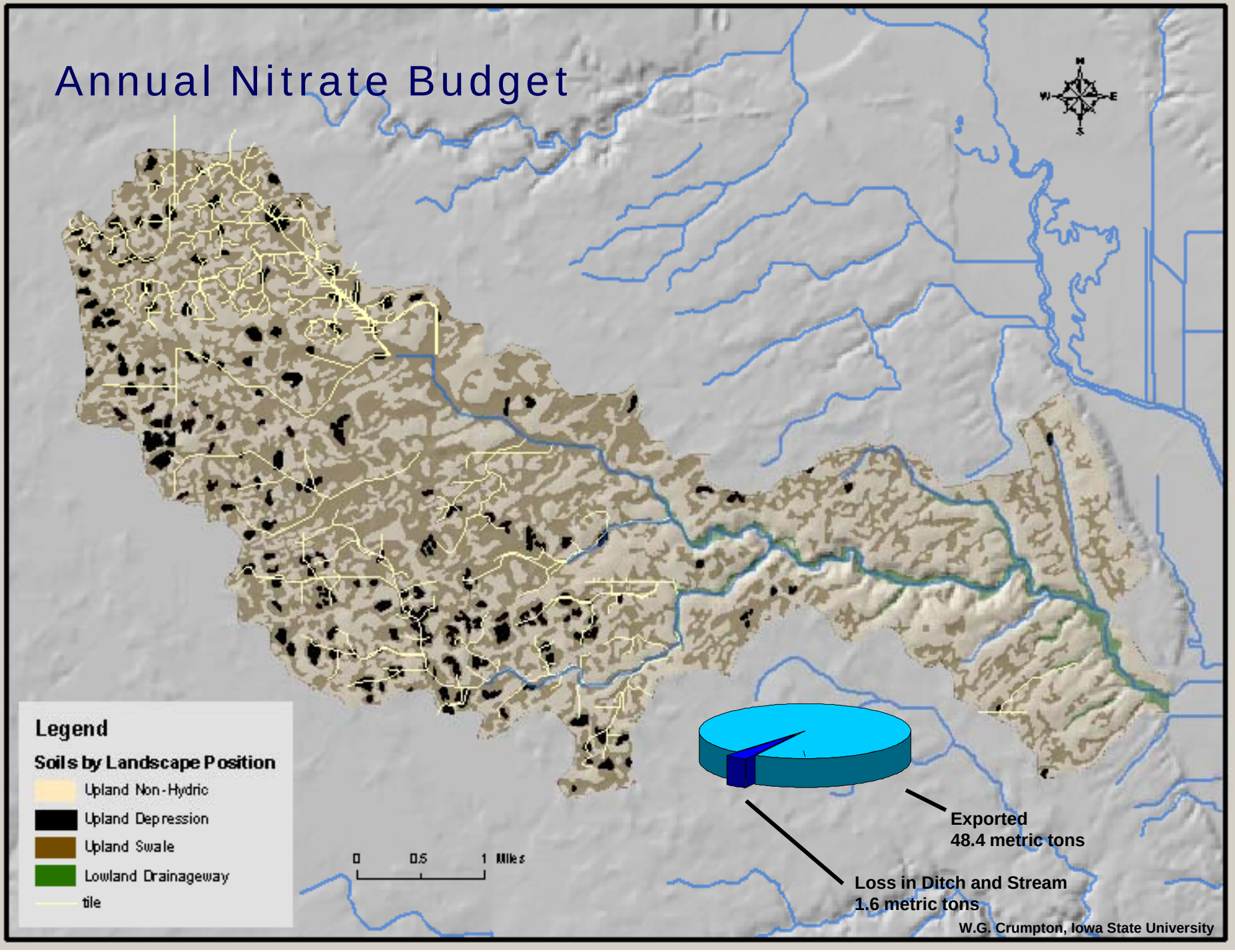
- Wetlands have been shown to be effective in reducing nutrient export particularly nitrate export
  - Performance dependent on magnitude and timing of nitrate loads along and capacity of wetland to remove nitrate
- Research is needed to better predict nutrient load reductions and determine the effectiveness under different patters of precipitation and timing of loading to the wetlands
- Siting of wetlands to intercept tile drainage is critical

Wetland Siting and Design for Watershed Scale Endpoints



W.G. Crumpton, Iowa State University

Annual Nitrate Budget



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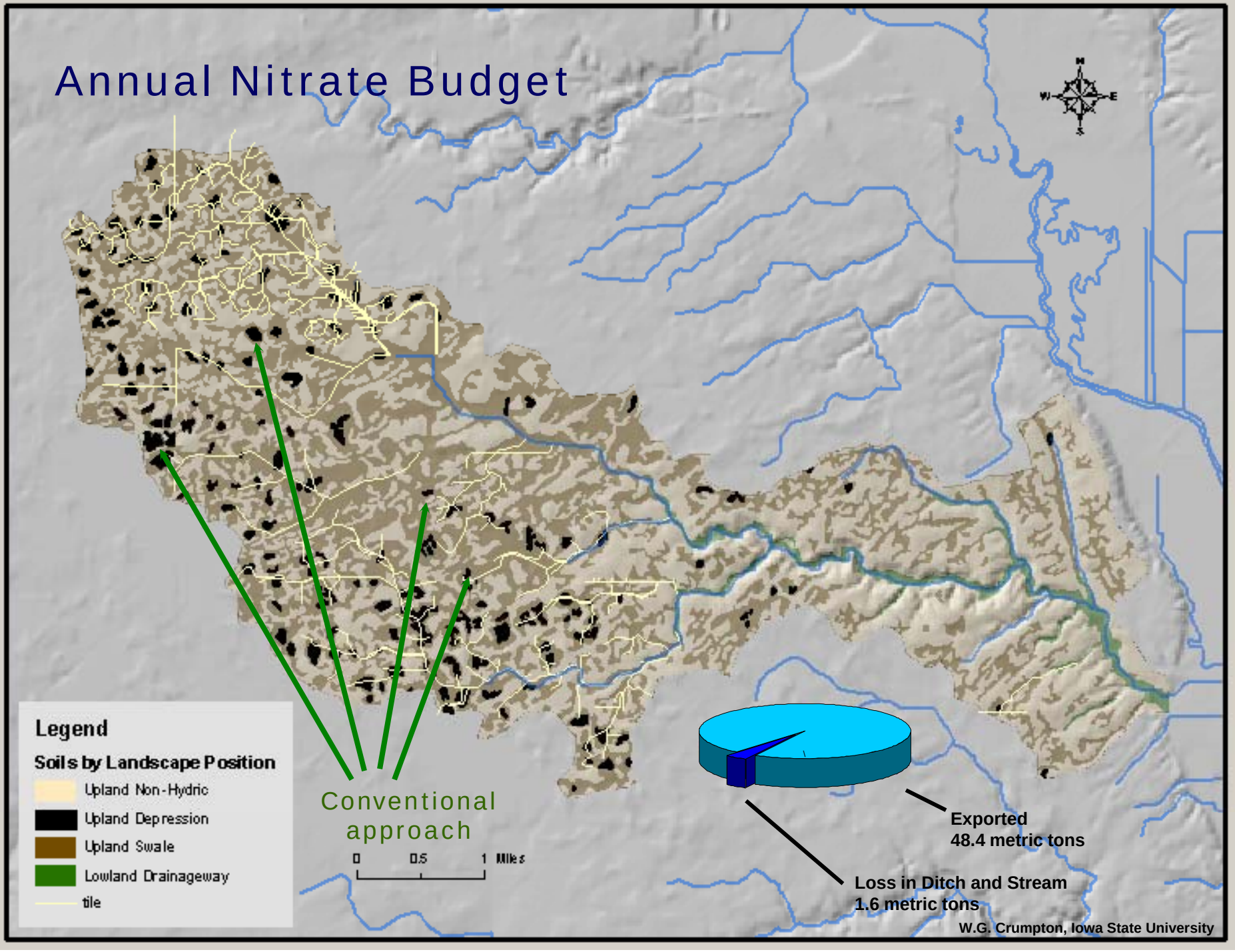

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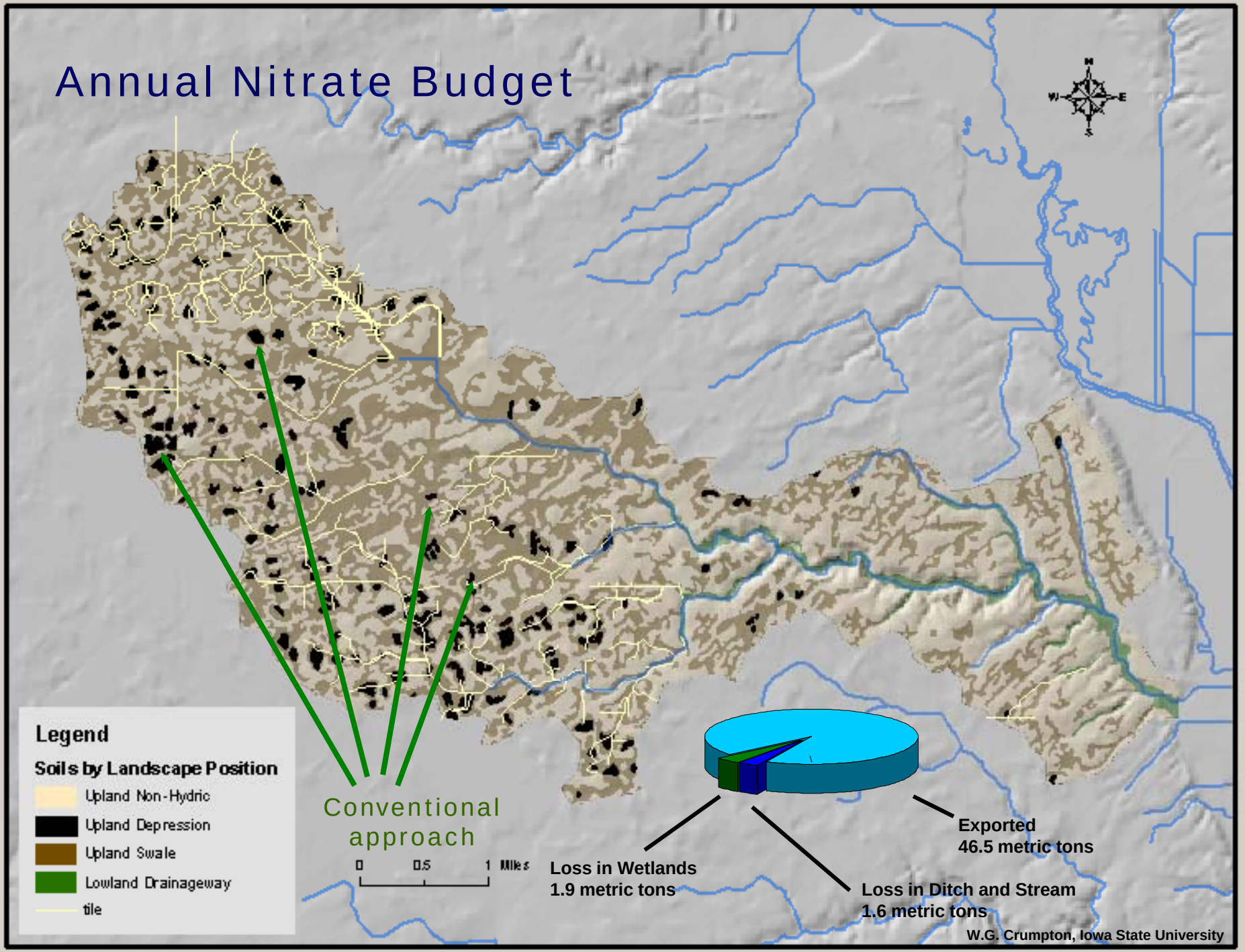

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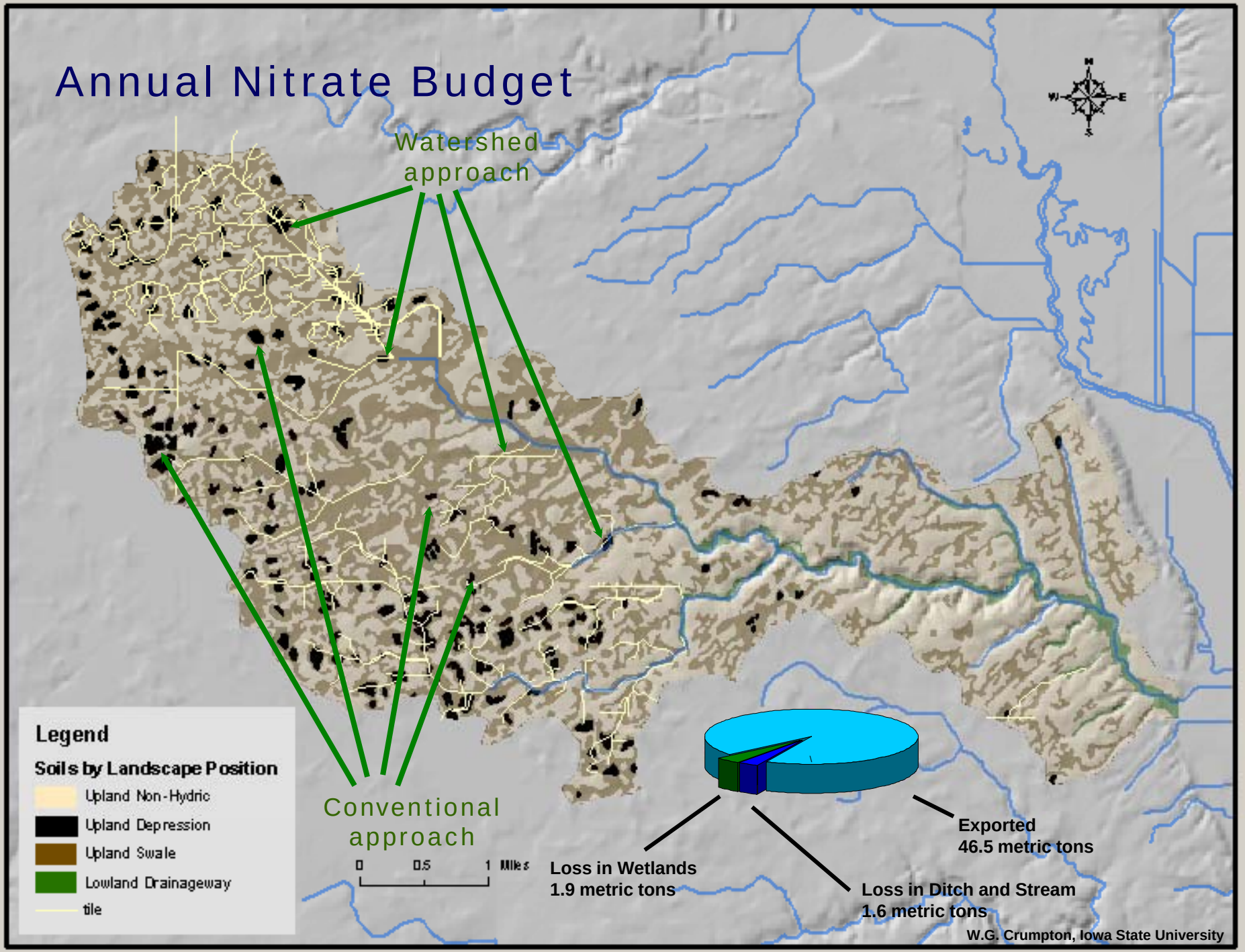

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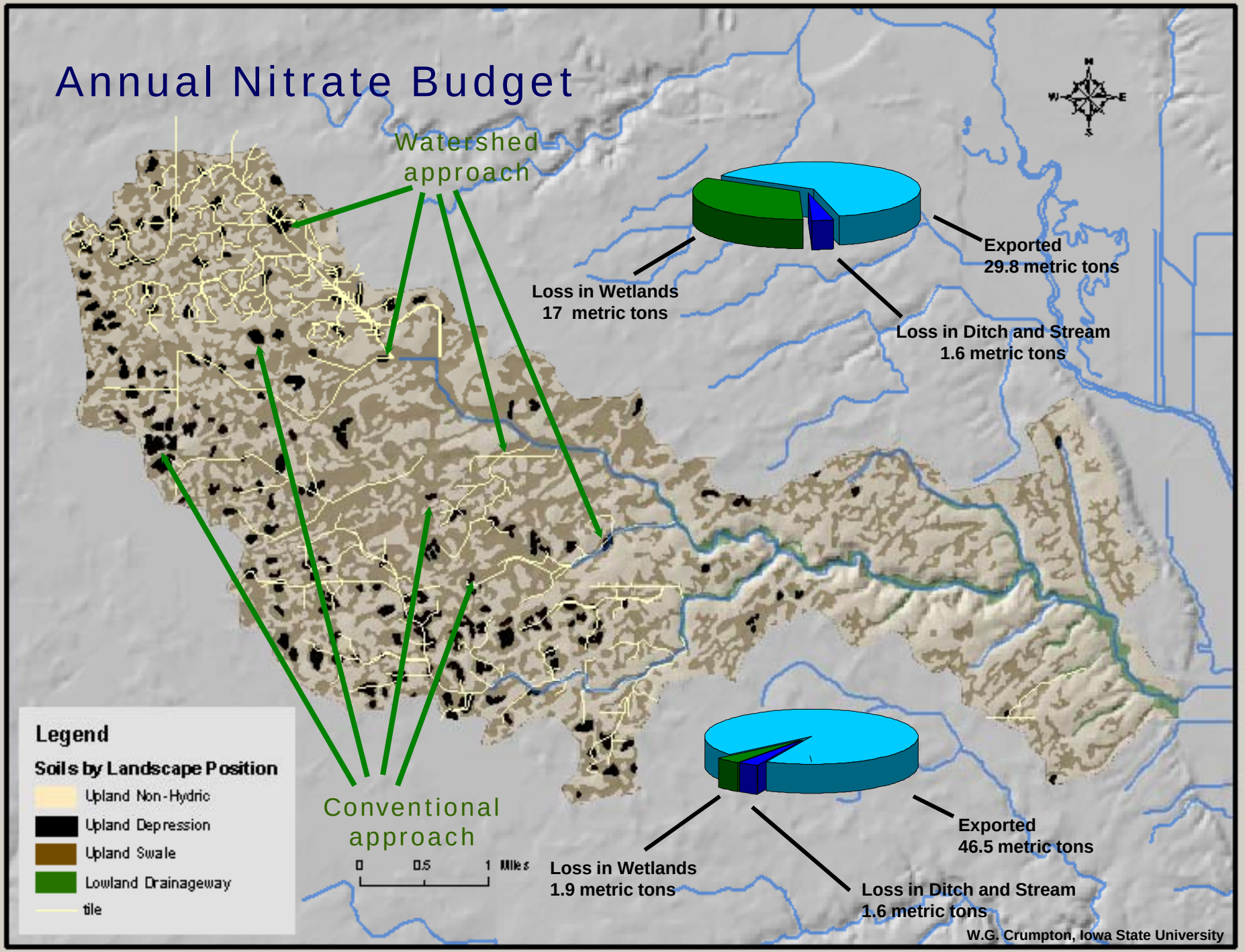

Summary

- Water quality improvements that can be gained by just improved in-field nutrient management may be limited
- Continuous living cover through cover crops or increased perennial vegetation has potential to reduce nutrient losses, increase water use, and increase infiltration
- Drainage systems should be designed and managed to minimize nutrient export factoring surface and subsurface flow

Summary

- Practices that slow the flow of water should be implemented and placed strategically to intercept flowing water
- Practices should be targeted to the land-water interface to provide water quality treatment before water enters downstream water bodies – these practices may also attenuate discharge hydrographs
- Practices need to be suited for the contaminant of concern

Panel

- Dr. William Crumpton
- Dr. Thomas Isenhart
- Dr. Tom Kaspar
- Dr. Dan Jaynes
- Dr. Matt Helmers

Panel Discussion

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