Manure Management Impacts on Surface-Water Runoff Quantity from a Wisconsin Agricultural Landscape

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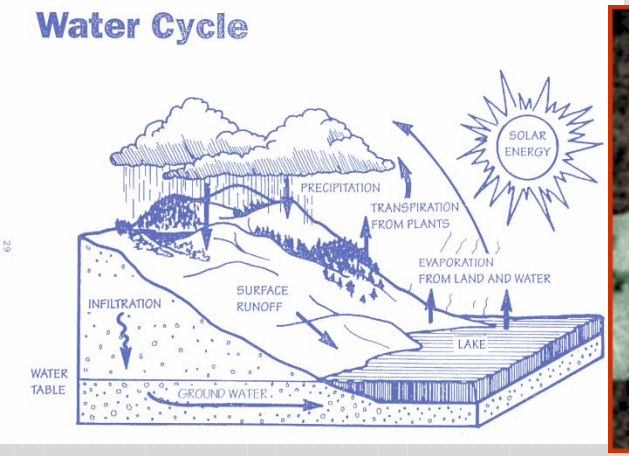
Nutrient Management: Managing the amount, source, placement, form and **timing** of the application of nutrients and soil amendments.

Purpose: For plant production, utilizing nutrients in soil reserve, legume N, manure nutrients and commercial fertilizers…

To minimize nutrient entry into surface water, ground water and atmospheric resources…

While maintaining / improving the physical, chemical and biological soil condition.

NRCS Nutrient Management Standard (590).



Manure management is an integral part of agricultural businesses that produce livestock.

Understanding relationships between runoff water quality vs. type, timing, rates, and methods of manure applications will help develop improved manure management practices for water quality.

Especially for timing: Winter Spread Manure

Livestock Manure in Wisconsin

- Applied in different ways and different times of the year, depending on producer management style.

- Surface applied or injected / soil incorporated.

- Some producers apply manure every day, others have storage.

Livestock Manure in Wisconsin

- Those with storage, wait to spread manure until crops are removed and the soil is firm enough to drive equipment on.

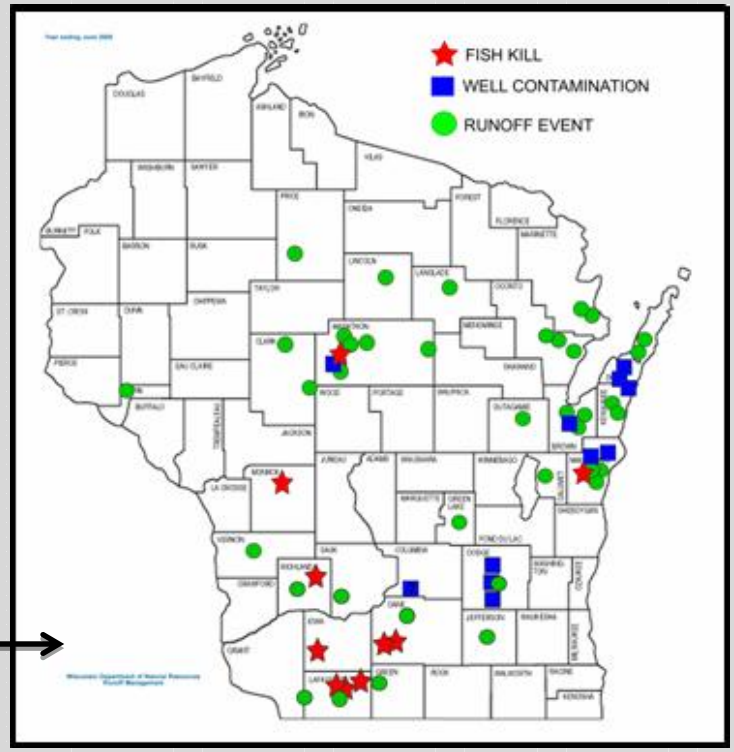
- In WI, these conditions typically occur in early spring - late in the fall - and into the winter.

Livestock Manure in Wisconsin

- Unfortunately, some of the time periods when WI producers spread manure coincide with seasonal periods when potential for surface-water runoff is high.

- This creates a potential risk to water resources.

Winter 2005 Manure Runoff Issues



On-Farm Research

Four years (Nov. 03 – Oct. 07) of discharge and water-quality data were collected from three field-size, paired basins on a private southwest WI farm.

Field edge discharge was monitored continuously and composite water samples for precipitation and snowmelt-induced runoff events were collected and analyzed for nutrients and sediment.

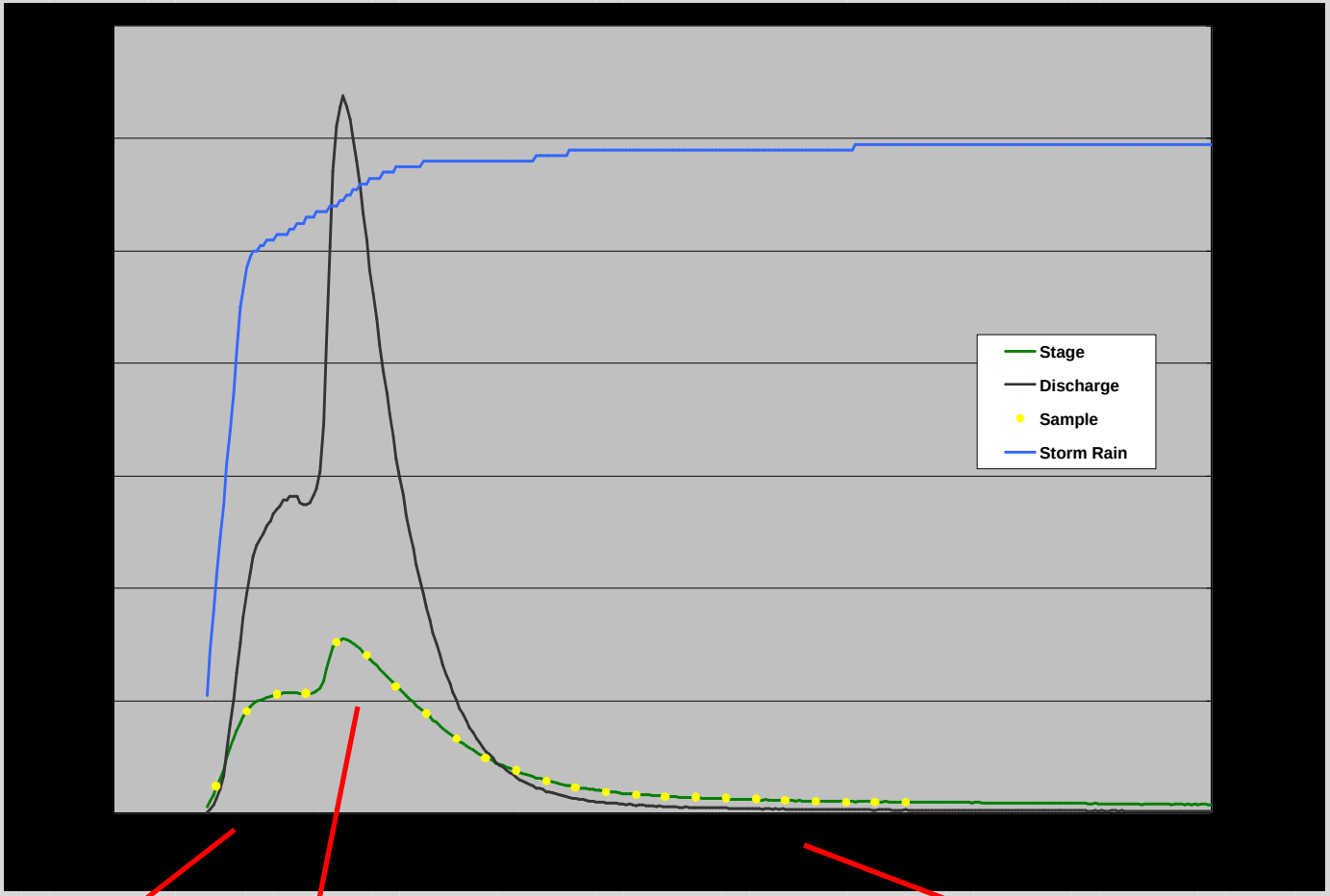
UW-Discovery Farms Partners With U.S. Geological Survey

- USGS equipment and methods are nationally recognized and beyond reproach.

Edge of Field Surface Water Monitoring Equipment

- Gauging station
- Nitrogen tank
- Refrigerator / ISCO sampler
- Data logger
- Connections to Flume
- Connections to weather
- Connections to power

Looking at a runoff sample set



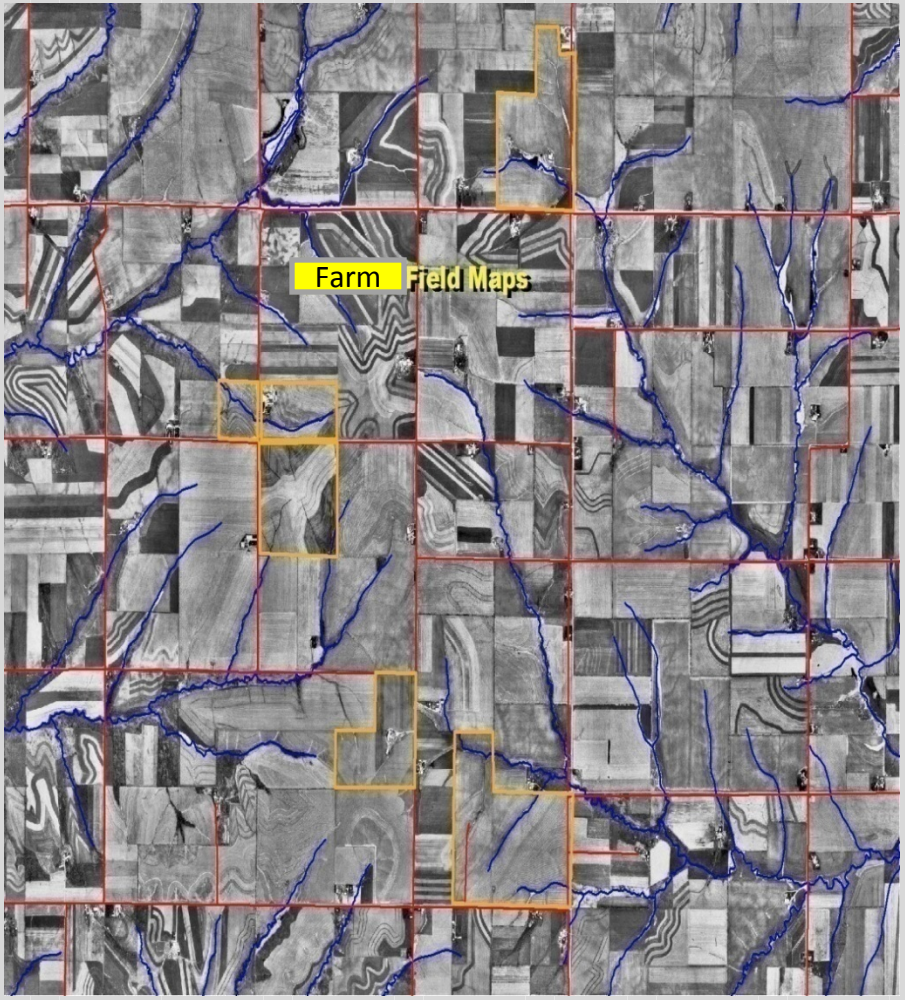
Constituent list

- Suspended sediment
- Total dissolved solids
- TKN
- Ammonium
- Nitrate
- Total P
- Dissolved reactive P
- Chloride
- Total Nitrogen
- Organic Nitrogen

On-Farm Research: The Farm

Southwest Wisconsin,
Numerous streams,
Un-glaciated landscape.

Farm management is no-till corn or soybeans on 4-6 % slope silt loam soil with terraces and grassed waterways in place.



Farm Management

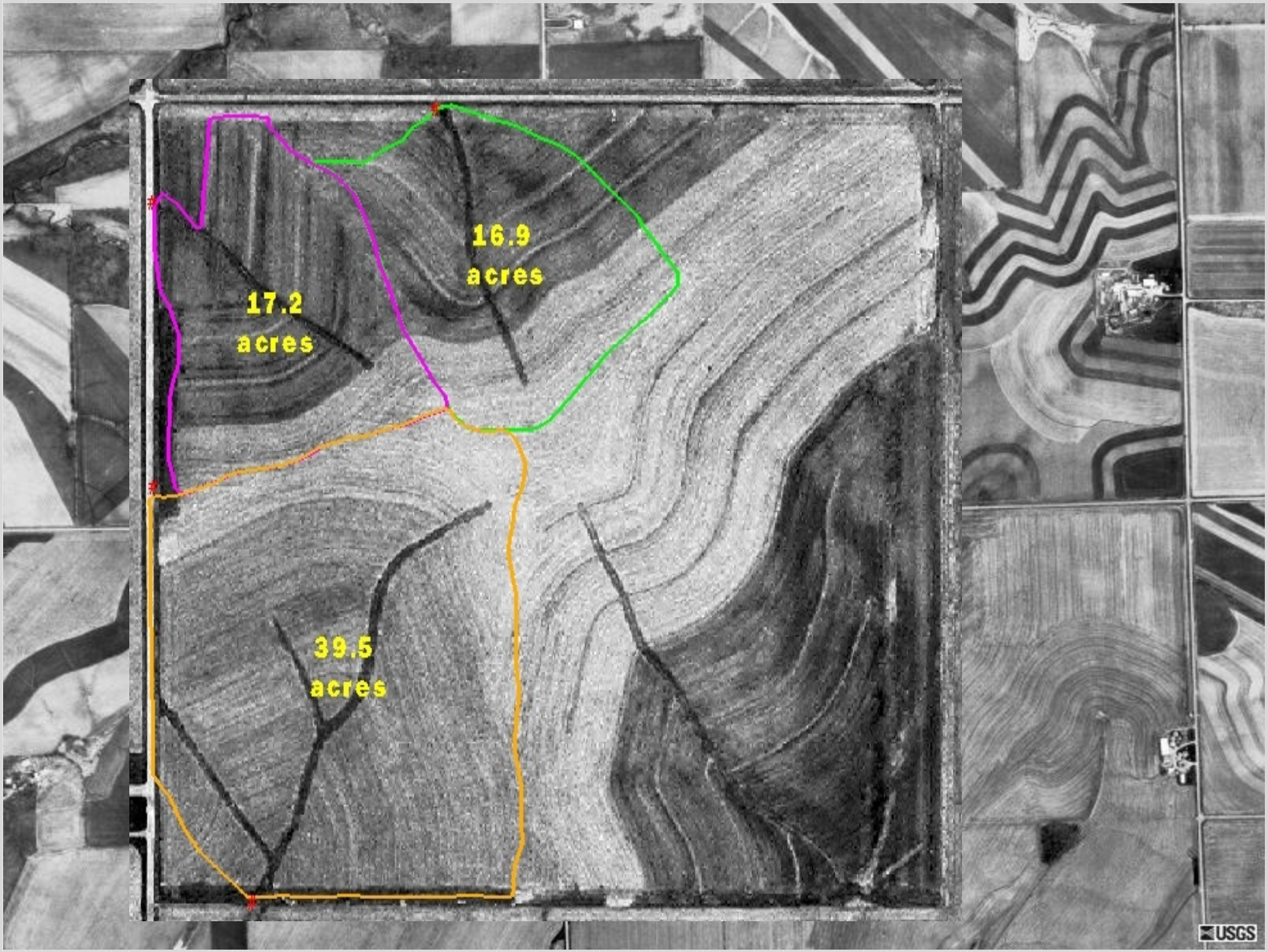
Family farm, located in Lafayette County, WI.

Livestock: 2 Beef feedlots, finish 600 + feeder cattle to market wt. Solid manure system, no storage.

Crops: 900 acres. Tama silt loam soil. Terraces, contour field lay out, waterways. Corn grain, corn silage, soybean. Direct plant no – till. 2/3 of corn grain stalks harvested as bedding.

Water Monitoring: 3 USGS flumes in upland waterways.

Farm Field & Sampling Basins



Post – Harvest Surface Residue

No-till corn-soybean cropping system for 10 + years.

Corn harvested as silage enters the winter season with > 60 % surface residue.

Evidence of 3 prior year crops can be seen on soil surface.

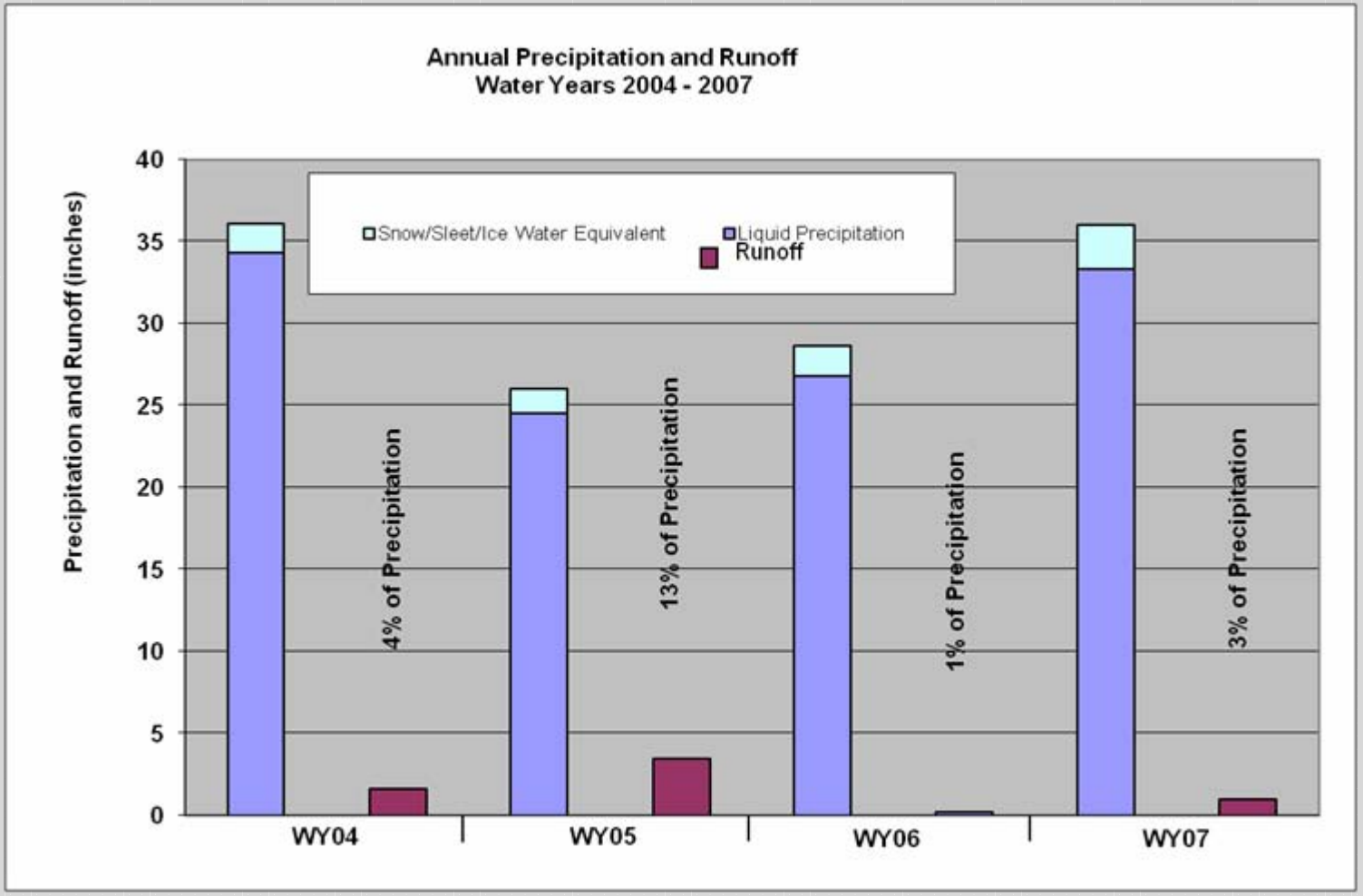
Winter Manure Application Impact On Surface Water Quality

- Livestock manure was applied at typical rates in either the fall or late winter just before snowmelt, such that both application time periods were monitored each year.

Winter Run-Off Sampling

Experience shows this is an important and challenging time to capture water samples!

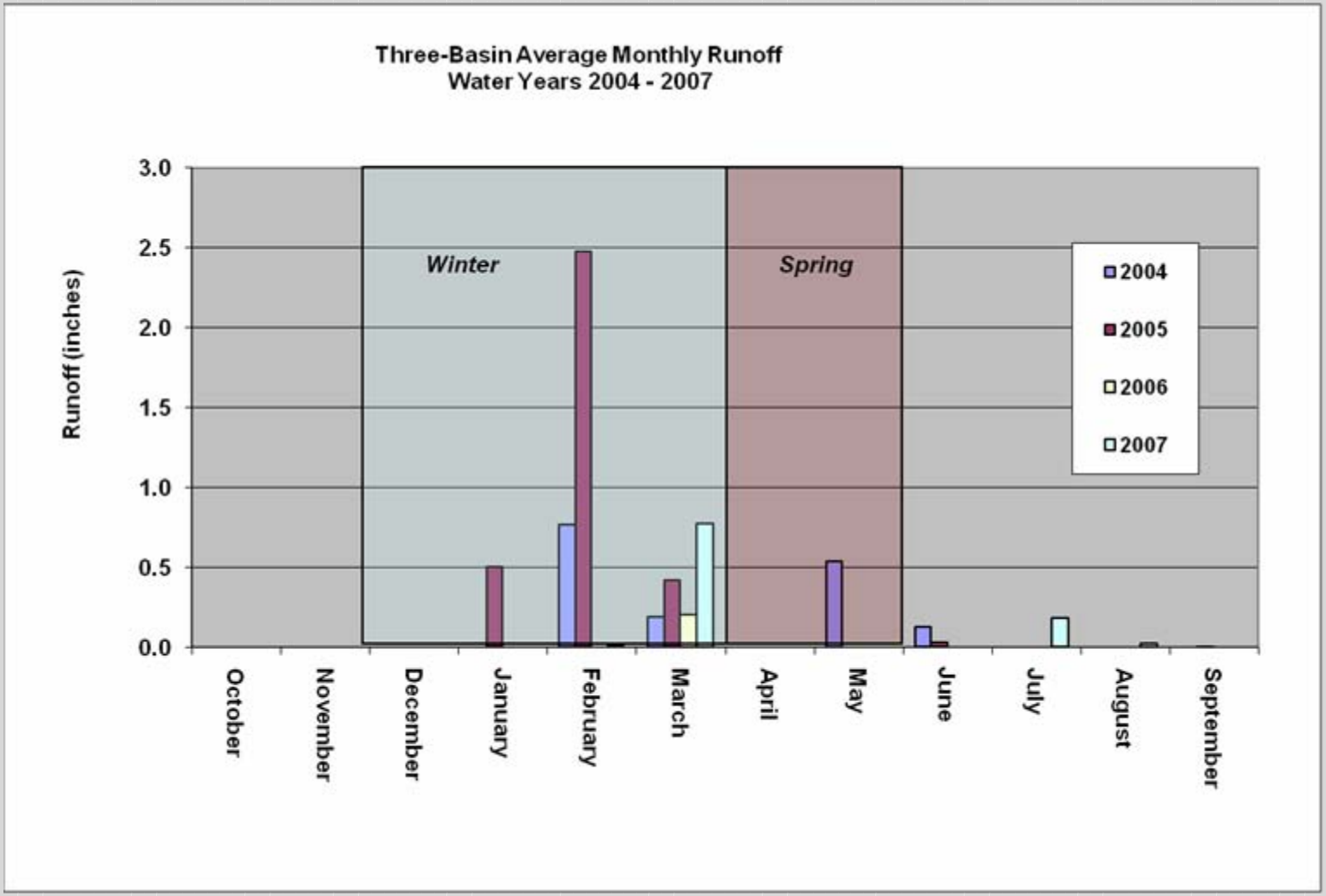
Runoff % of Precipitation



Above or below average precipitation in any year was not necessarily related to runoff amount.

On average, 5 % of measured precipitation contributed to surface water runoff.

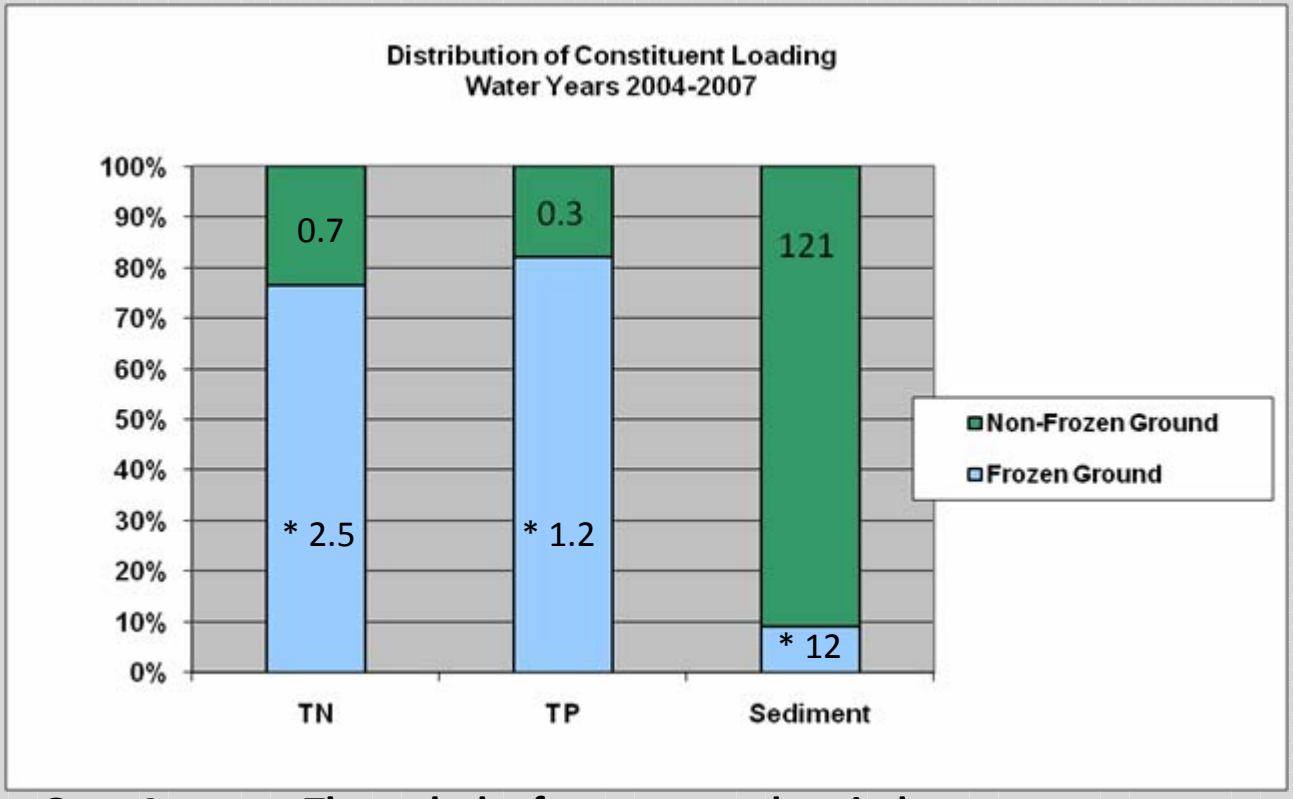
Runoff Timing



82% of surface-water runoff occurred when ground was frozen.

Remaining runoff: in spring when vegetative cover was minimal and soils were wet.

N, P, and Sediment Loss From Frozen or Non-Frozen Ground



Over 4 years – Through the <u>frozen ground period:</u>

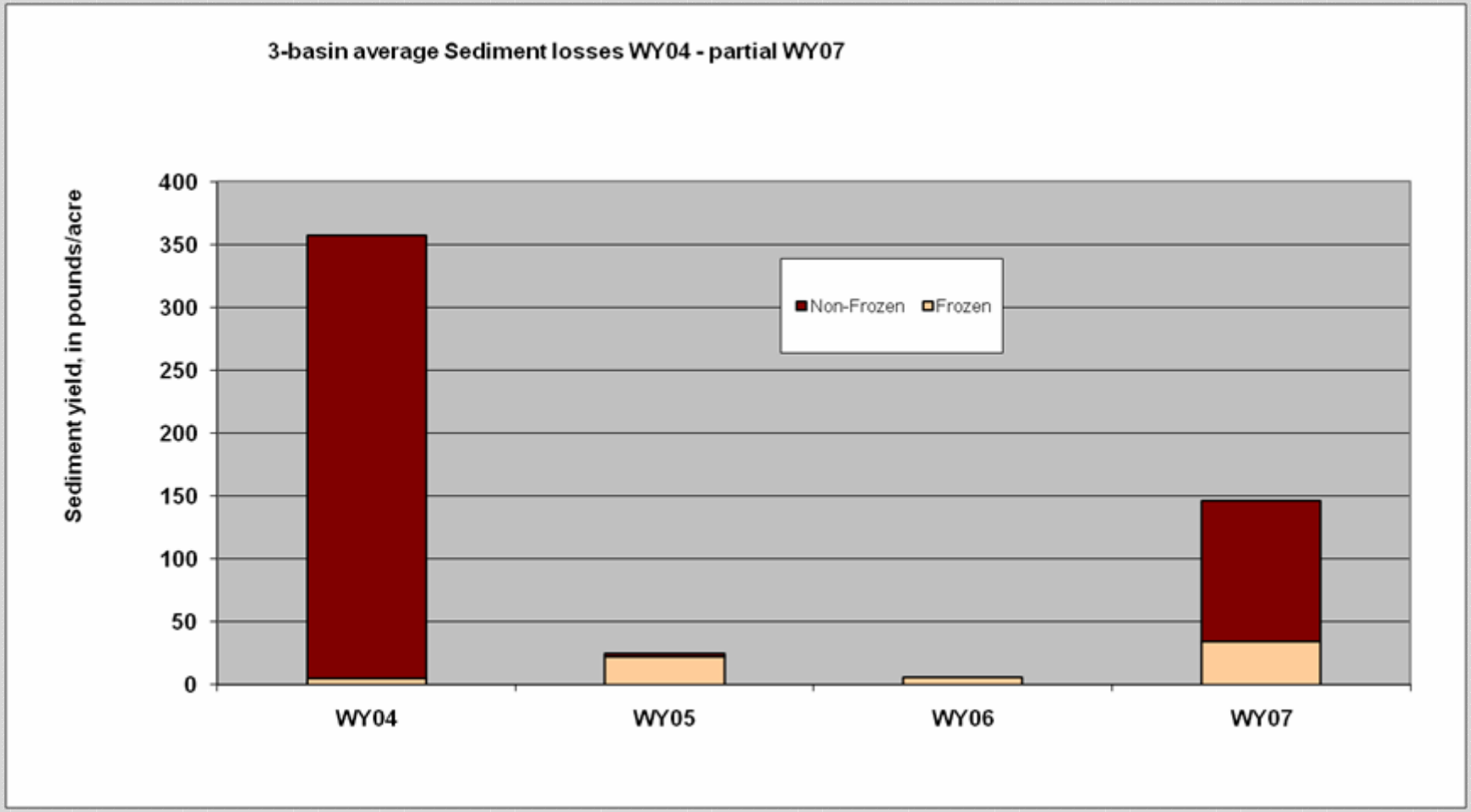
> 75 % of annual N was lost.

> 80 % of annual P was lost.

< 10 % of annual sediment was lost.

* 4 years, 3 sites, with and without winter manure. Average lb/ac/yr.

Edge of Field Soil Sediment Loss



Through the frozen ground period, suspended sediment loss ranged from 5 – 20 lbs/ac each yr.

Tolerable soil loss for this soil = 5 t/ac/yr.

Most total P lost was dissolved; not associated with sediment loss.

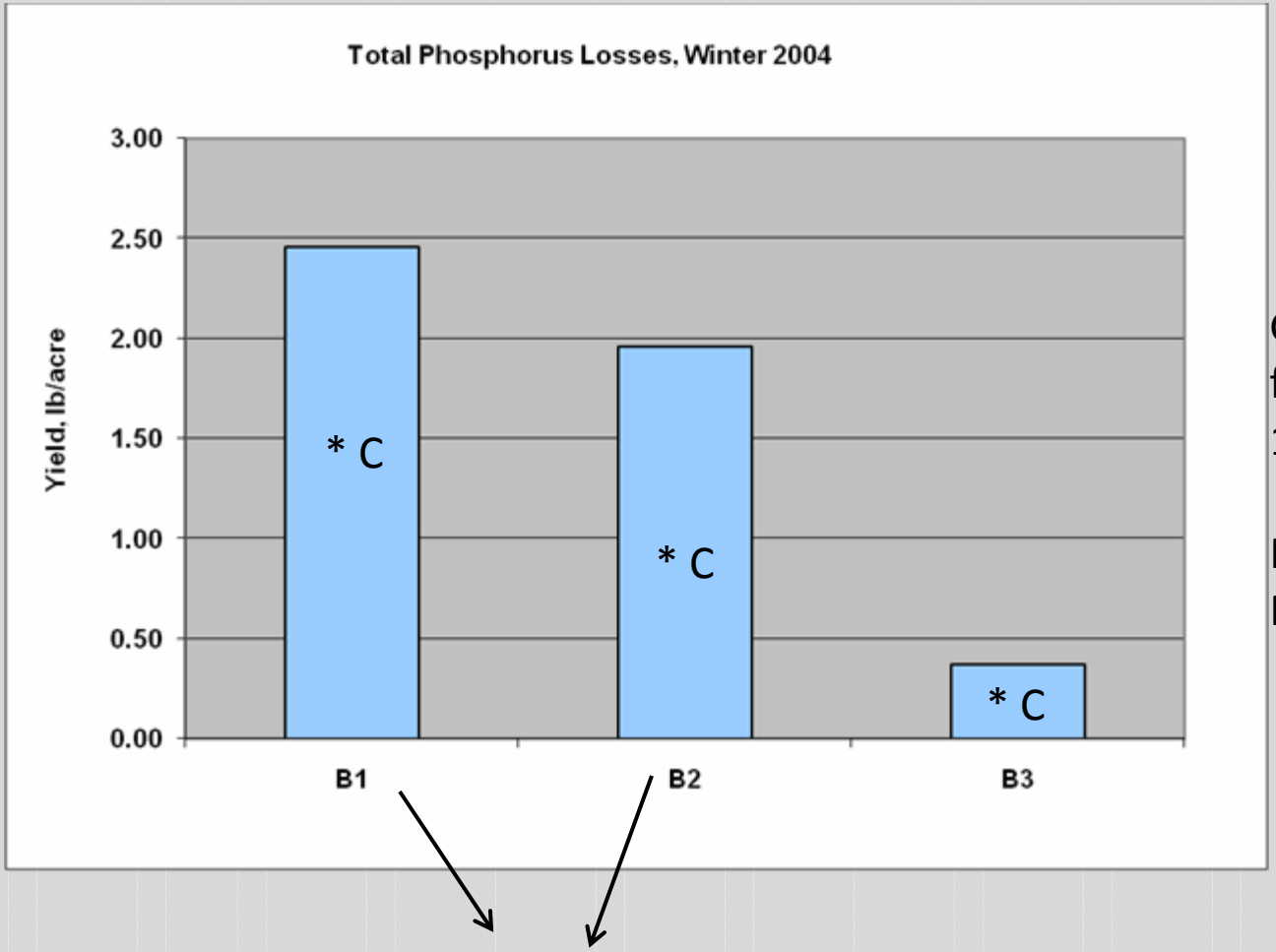
Snowmelt, Feb. 2004

- Samples represent the first 2 days of snowmelt, 2004.

- With and without February applied manure.

Manure Application Timing vs. Surface-Water Quality in Frozen Ground Period

P



Ground was frozen on Feb. 13.

Runoff began on Feb. 18.

Feb. 13, 04: 1,500 gal/ac liquid dairy

* 2003 crop

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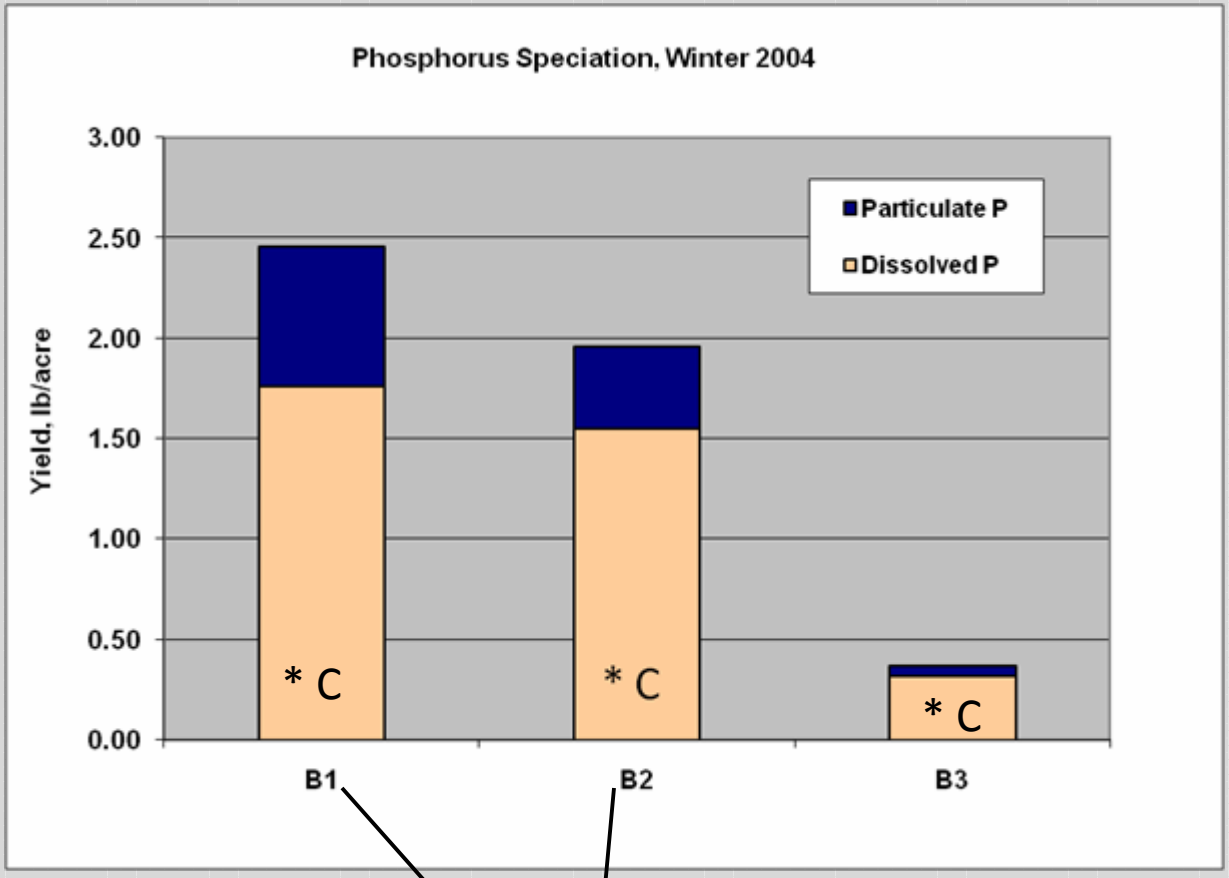
P



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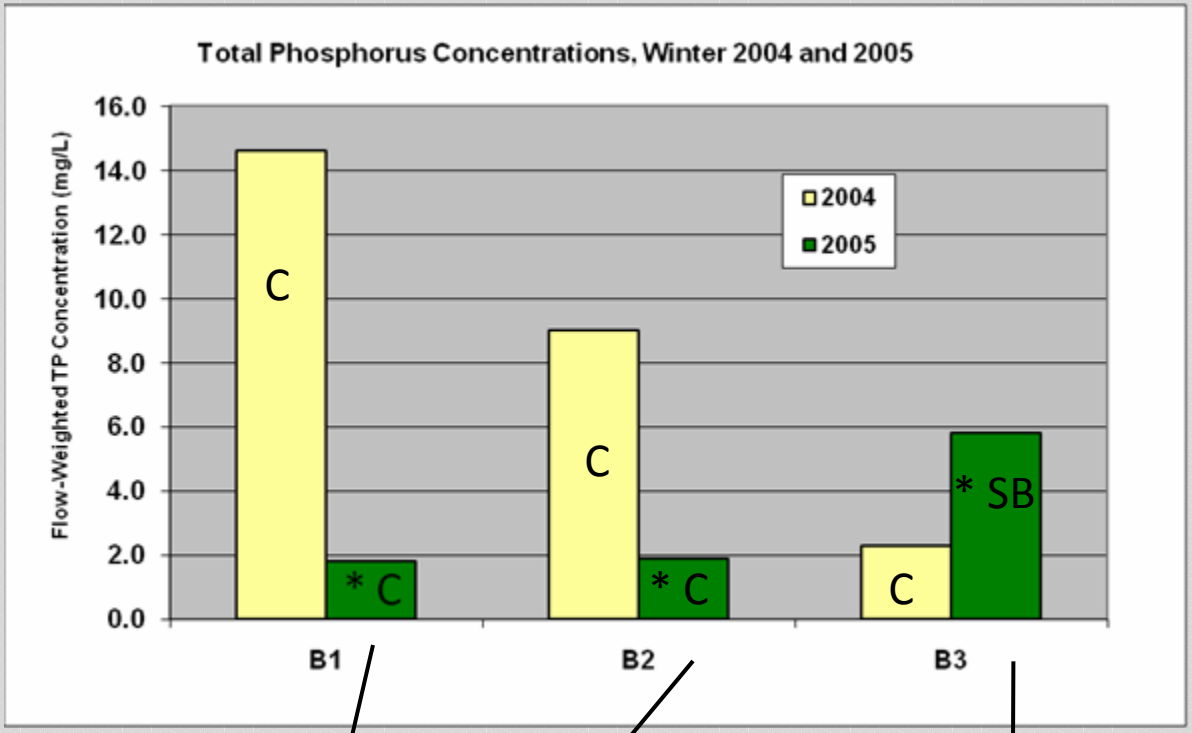


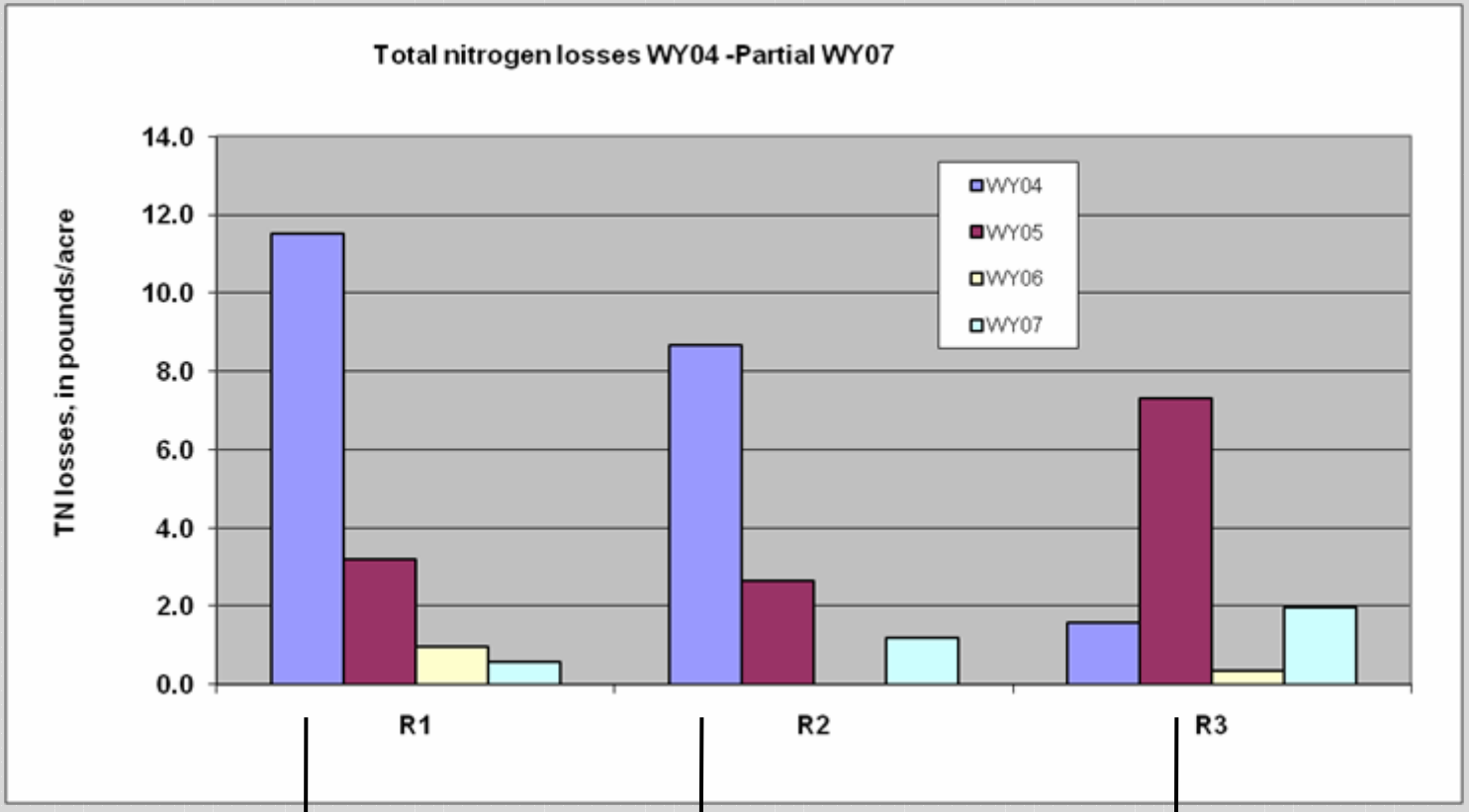
Oct. 04: 3.5 t/ac solid beef

Oct. 04: 3,100 gal/ac liquid dairy
Oct. 04: 3.6 t/ac solid beef
Jan. / Feb. 05: 5.9 t/ac solid beef

* 2004 crop

Manure Application Timing vs. Surface-Water Quality in Frozen Ground Period

N

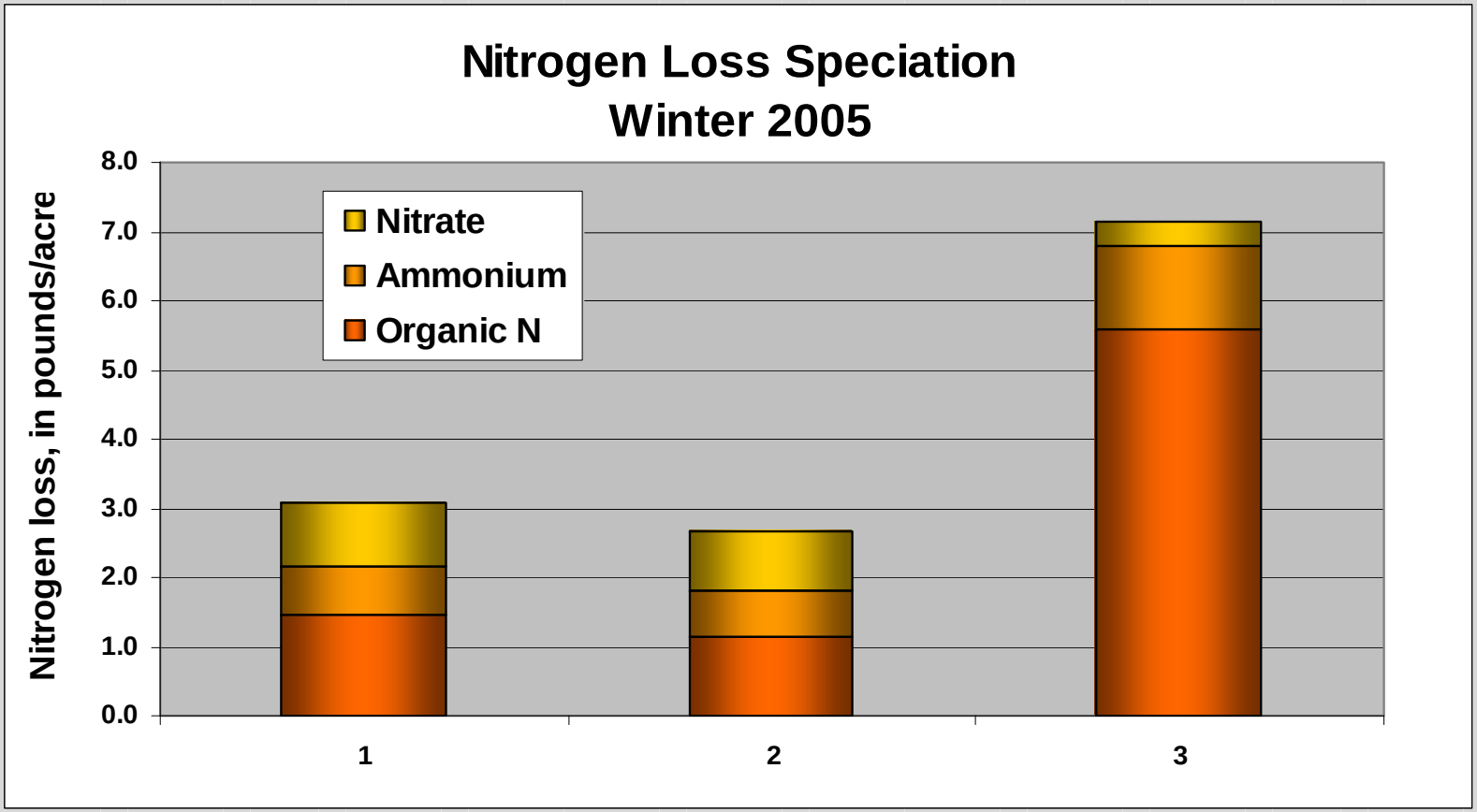


Liquid dairy manure applied immediately before runoff (Feb. 04)

Solid beef manure applied immediately before runoff (Feb. 05)

Manure Application Timing vs. Surface-Water Quality in Frozen Ground Period

N



Basins with manure applied shortly before snowmelt had total N losses > 2X higher than basins with fall manure.

Total N losses where manure was applied shortly before snowmelt was mostly organic and ammonium forms.

Summary of Findings

Over the four years of this study:

- **> 80 percent of surface-water runoff occurred when the ground was frozen.**

- Most surface-water runoff occurred in late winter (**Feb. and Mar.**) and again in spring, when vegetative cover was minimal and soils were wet (Apr. – Jun.).

Summary of Findings

Over the four years of this study:

- A small percentage of annual suspended sediment loss occurred when the ground was frozen.
- > 75 percent of annual **N** losses occurred when the ground was frozen.
- > 80 percent of annual **P** losses occurred when the ground was frozen.
- Nutrients lost to surface-water runoff in the frozen ground period were mostly in the **dissolved form**, influenced by late winter manure applications.

Summary of Findings

Over the four years of this study:

- Most nutrient losses were likely due to manure application on frozen & snow covered ground, shortly before snowmelt.

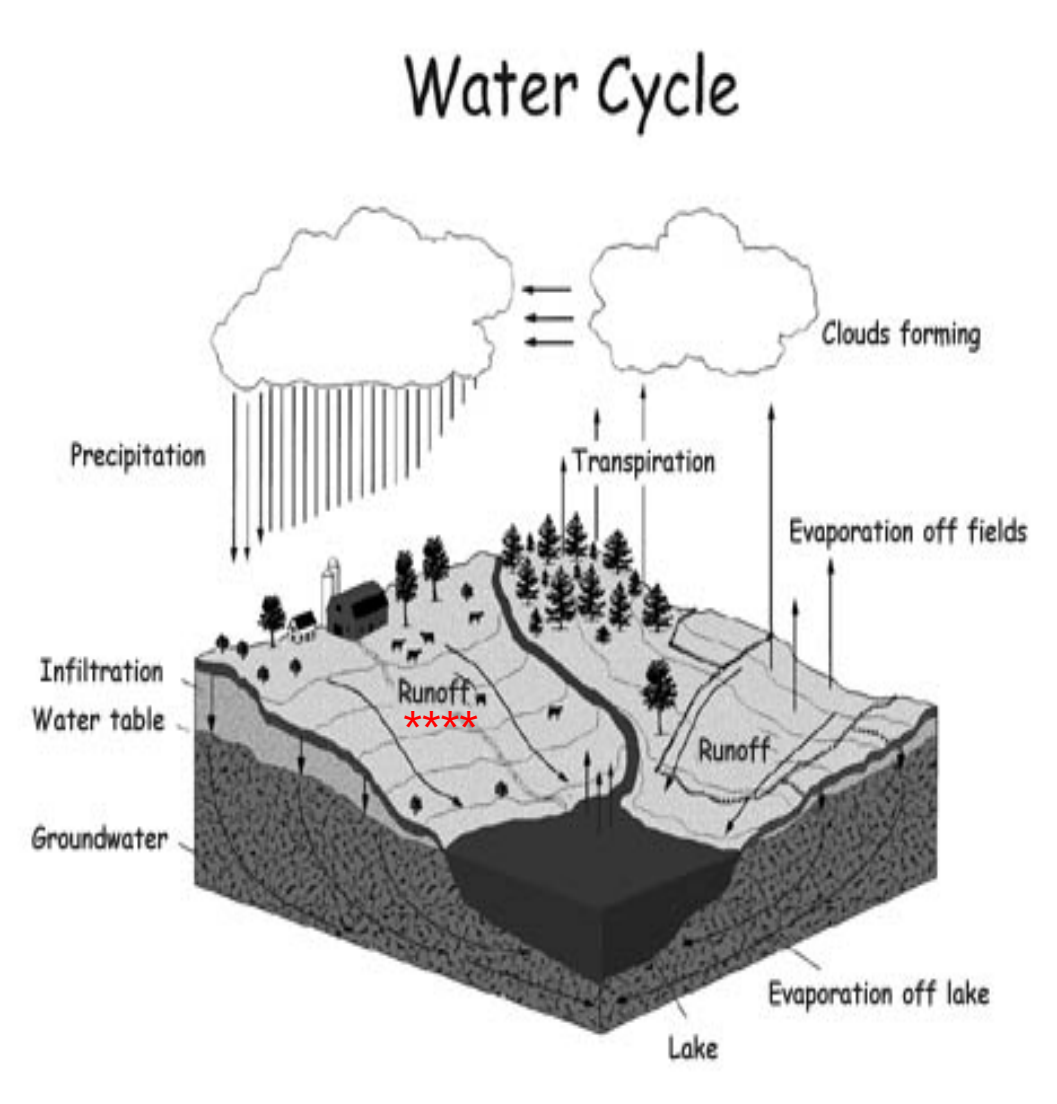
- Both **liquid (dairy) and solid (beef) manure** applications resulted in nutrient losses to surface-water runoff.

Summary of Findings

Over the four years of this study:

- **Timing** is critical to avoid detrimental impact to water quality when spreading winter manure.
- **Livestock manure applied immediately prior to runoff events has a high risk of increasing N and P concentrations in surface-water runoff.**
- Understanding the relationships between water quality and the **timing**, rates, and methods of manure application – **particularly in the winter** – is a big step toward understanding the impact of Wisconsin agriculture on the environment.

Action: Our Move



1. There are usually more than 1 snowmelt runoff events each winter.

2. Know how your landscape melts
   - Which fields runoff first?
   - Which fields runoff last?
   - Where does the runoff go?

3. Watch the weather
   -Anticipate the melt(s)

4. Spread (or don't spread) manure accordingly.

5. **Avoid manure applications 1 week before (and during) snowmelt runoff events.**

6. Producers: Manage this way.

7. Consultants: Consult this way.

Future Research Needs

- Impacts of manure applied to frozen/snow-covered ground in early winter compared to late winter.
- Distance / rate / manure type impacts.
- Manure interactions with snow pack, ice layers, soil surface, soil biology.
- Wintertime runoff “forecasting”
- Subsurface Tiles

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