

# Manure Phosphorus Balance: What's the Big Deal?



**Don Flaten**  
**Professor, Dept. of Soil Science, U of M and**  
**Chair, National Centre for Livestock and the Environment**



# Why the concern about manure P balance?

# Frequency of Water Quality Problems is Increasing



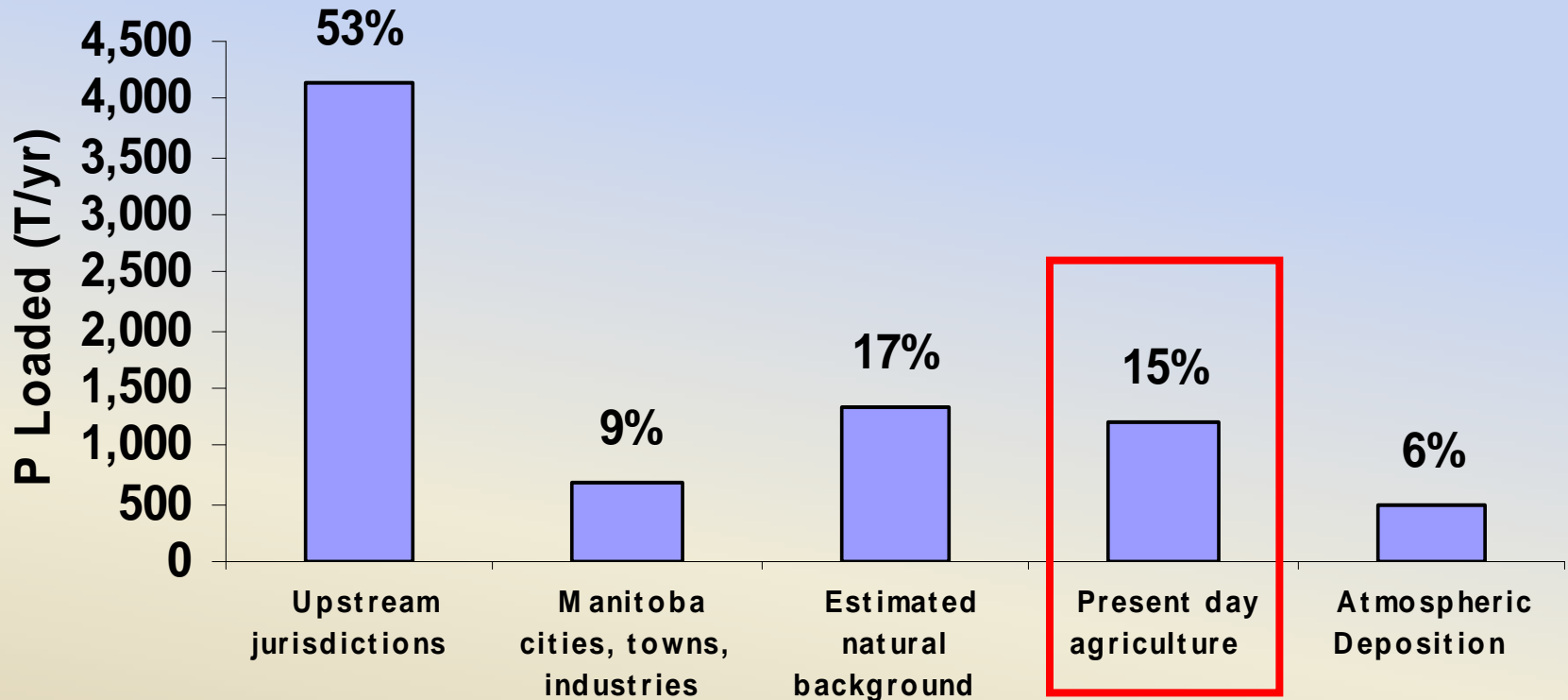
# Main Cause of "Algae" Growth: Excess P

- Blue-green “algae” (cyanobacteria) grow at very low conc’ns of P (20-50 ppb)
- Problems:
  - Oxygen depletion and fish kills
  - Nerve and liver toxins ... livestock & wildlife mainly at risk



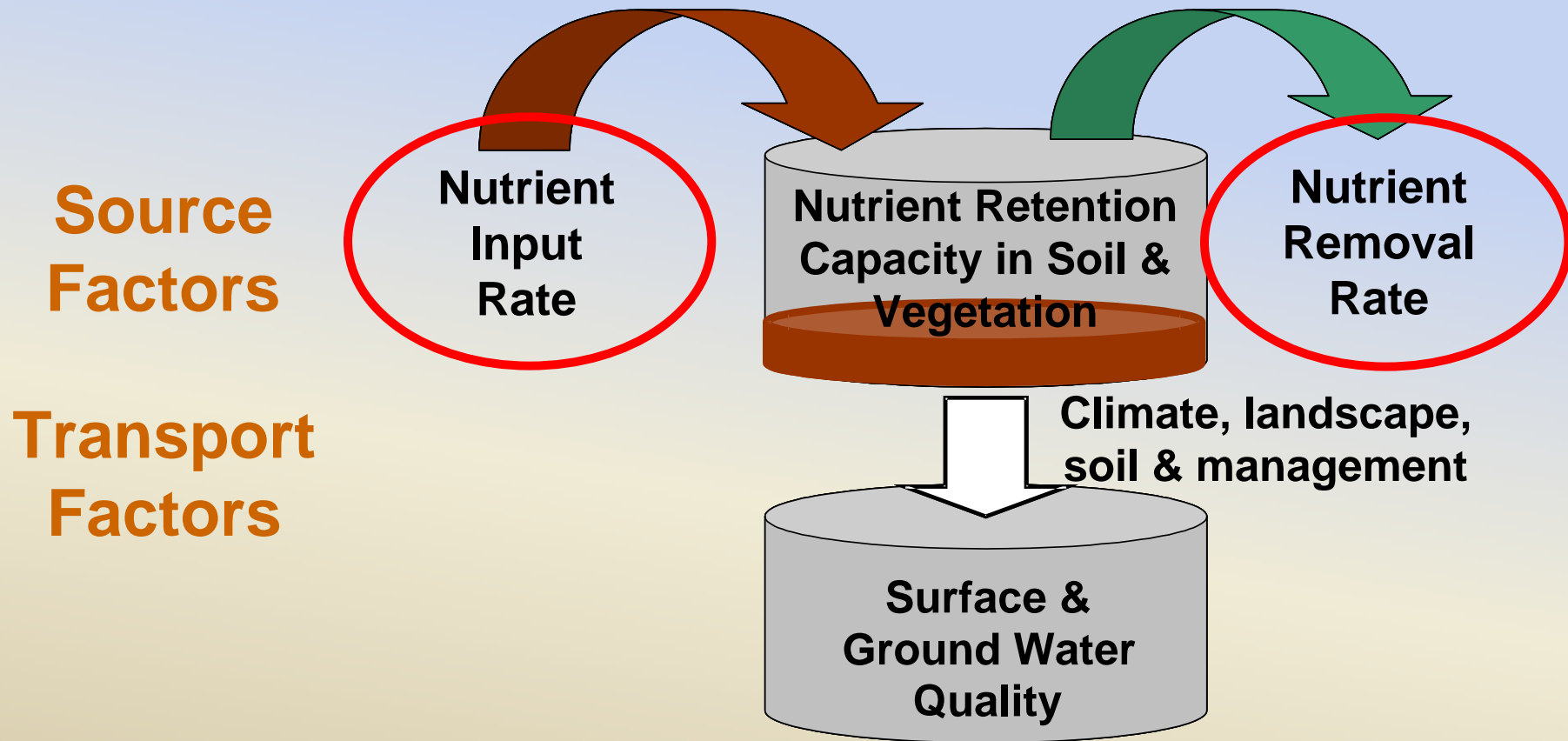
Photo: MB Conservation

# P loading into Lake Winnipeg comes from many sources



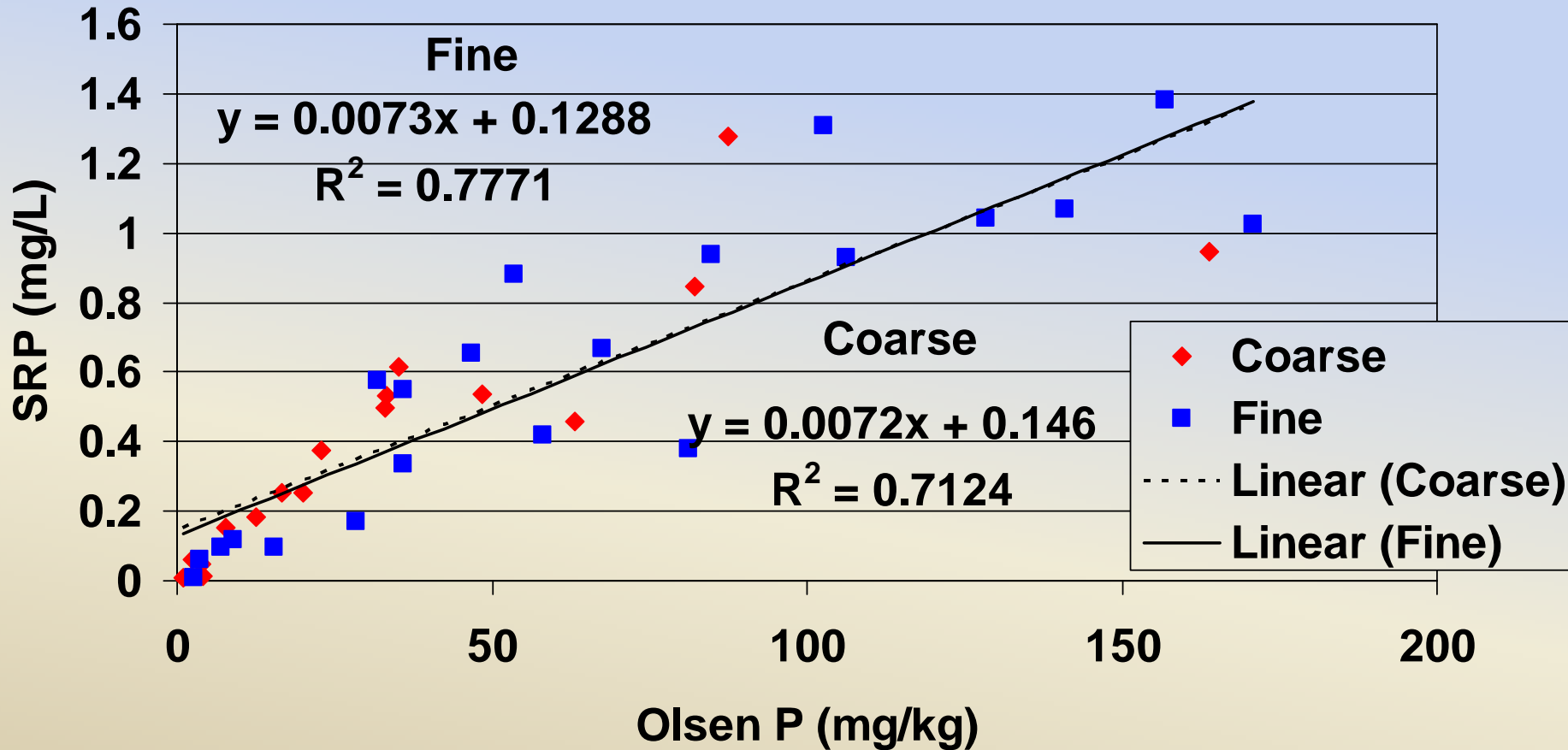
Manitoba Water Stewardship. 2006. Questions and Answers: Water Quality Management Zones for Nutrients (data are estimated for 1994-2001)

# Balancing P input with removal is critical for preventing excess soil test P accumulation ... or loss in soil fertility & crop productivity

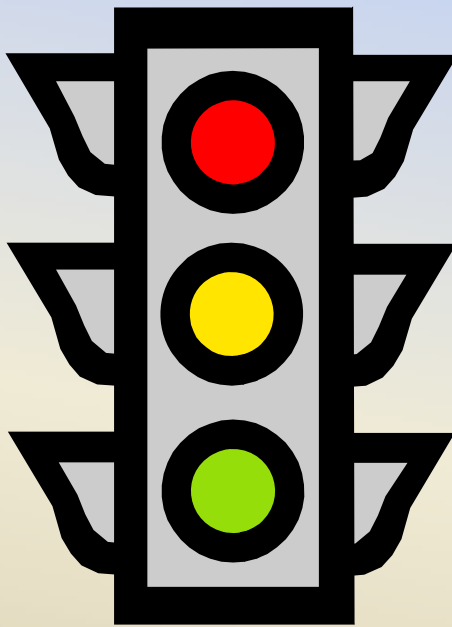




# Olsen soil test P is strongly related to soluble P concentrations in simulated runoff from Manitoba soils



# Manitoba's Phosphorus Regulations (For Manure and Synthetic Fertilizer)



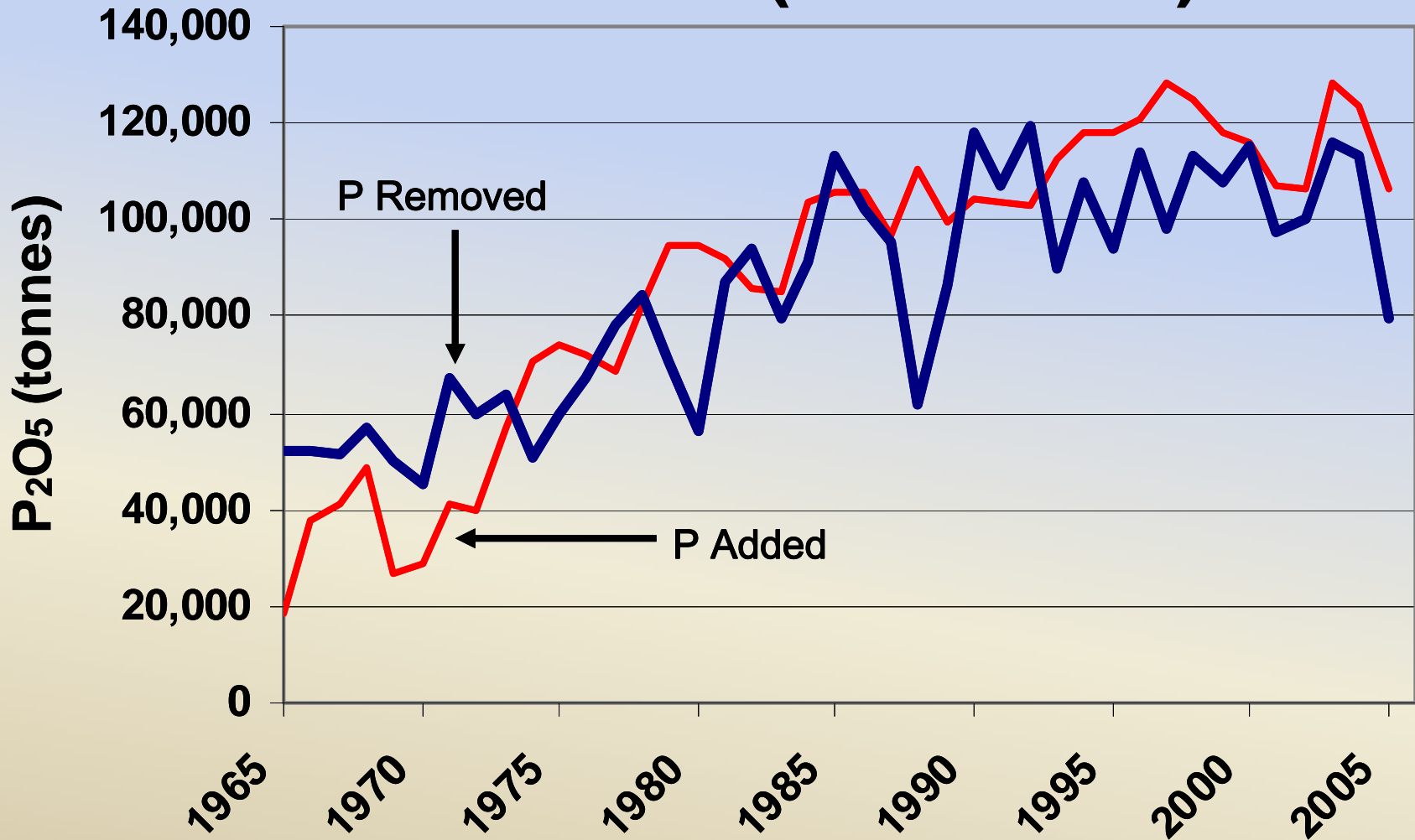
Soil Test P*	Maximum Rate of Manure P Application
>180 ppm	No P application
120-180 ppm	Apply P up to <u>1x</u> crop removal rate
60-120 ppm	Apply P up to <u>2x</u> crop removal rate
<60 ppm P	Apply manure for crop <u>N requirements</u>

\* sodium bicarbonate (Olsen) extraction method

# Fertilizer P Balance



# Crop Removal and Replacement of P in Manitoba (1965-2006)



# Livestock Manure: A Rich Source of P for Crops



- Ratio of available N:P<sub>2</sub>O<sub>5</sub> ratio of most manures is **< 1:1**
- Ratio of N:P<sub>2</sub>O<sub>5</sub> removed by most crops **> 2:1**
- Application of manure to meet the crop's N requirements results in application of enough P for several years of crop production

# Nutrient Analyses for Livestock Manures

Livestock type	Nutrient Content*		N:P <sub>2</sub> O <sub>5</sub>
	Avail. N	P <sub>2</sub> O <sub>5</sub>	Ratio
Dairy cows	20	21	0.97
Hogs, slaughter	22	23	0.96
Chickens, broilers	63	64	0.98
Beef cattle, feeders	4.1	6.4	0.64

\* lb/1000 gallons except lb/ton for beef manure

(Source: Tri-Provincial Manure Application and Use Guidelines)

# Application of liquid hog manure or solid cattle manure to supply crop N requirements supplies several years of P for annual crops<sup>1</sup>

Barley with 80 bu/ac yield goal	Hog Manure	Cattle Manure
Target N Rate (net basis, lb N/ac) <sup>2</sup>	80	80
Manure Appl'n Rate (gal or t/ac)	3,390	21
P Application Rate (lb P <sub>2</sub> O <sub>5</sub> /ac)	72	134
P Removal Rate (lb P <sub>2</sub> O <sub>5</sub> /ac) <sup>3</sup>	35	35
<b>P Surplus (lb P<sub>2</sub>O<sub>5</sub>/ac)</b>	<b>37</b>	<b>99</b>

<sup>1</sup> Manure analyses are from the Tri-Provincial Manure Application and Use Guidelines

<sup>2</sup> Assumes all manure is spring applied, by subsurface injection, with no significant volatilization loss of NH<sub>4</sub>-N

<sup>3</sup> Assumes that P is removed as grain only

# Application of liquid hog manure or solid cattle manure to supply crop N requirements supplies many years of P for perennial forage<sup>1</sup>

Grass for hay with 3 t/ac yield goal	Hog Manure	Cattle Manure
Target N Rate (net basis, lb N/ac) <sup>2</sup>	150	150
Manure Appl'n Rate (gal or t/ac)	9,415	43
P Application Rate (lb P <sub>2</sub> O <sub>5</sub> /ac)	199	279
P Removal Rate (lb P <sub>2</sub> O <sub>5</sub> /ac) <sup>3</sup>	<del>5 30</del>	<del>5 30</del>
<b>P Surplus (lb P<sub>2</sub>O<sub>5</sub>/ac)</b>	<b>194 <del>170</del></b>	<b>274 <del>249</del></b>

<sup>1</sup> Manure analyses are from the Tri-Provincial Manure Application and Use Guidelines

<sup>2</sup> Assumes all manure is spring applied, by subsurface injection, with no significant volatilization loss of NH<sub>4</sub>-N

~~<sup>3</sup> Assumes that all forage is mechanically harvested as hay and not harvested by grazing animals~~

# How much manure P can Manitoba use?

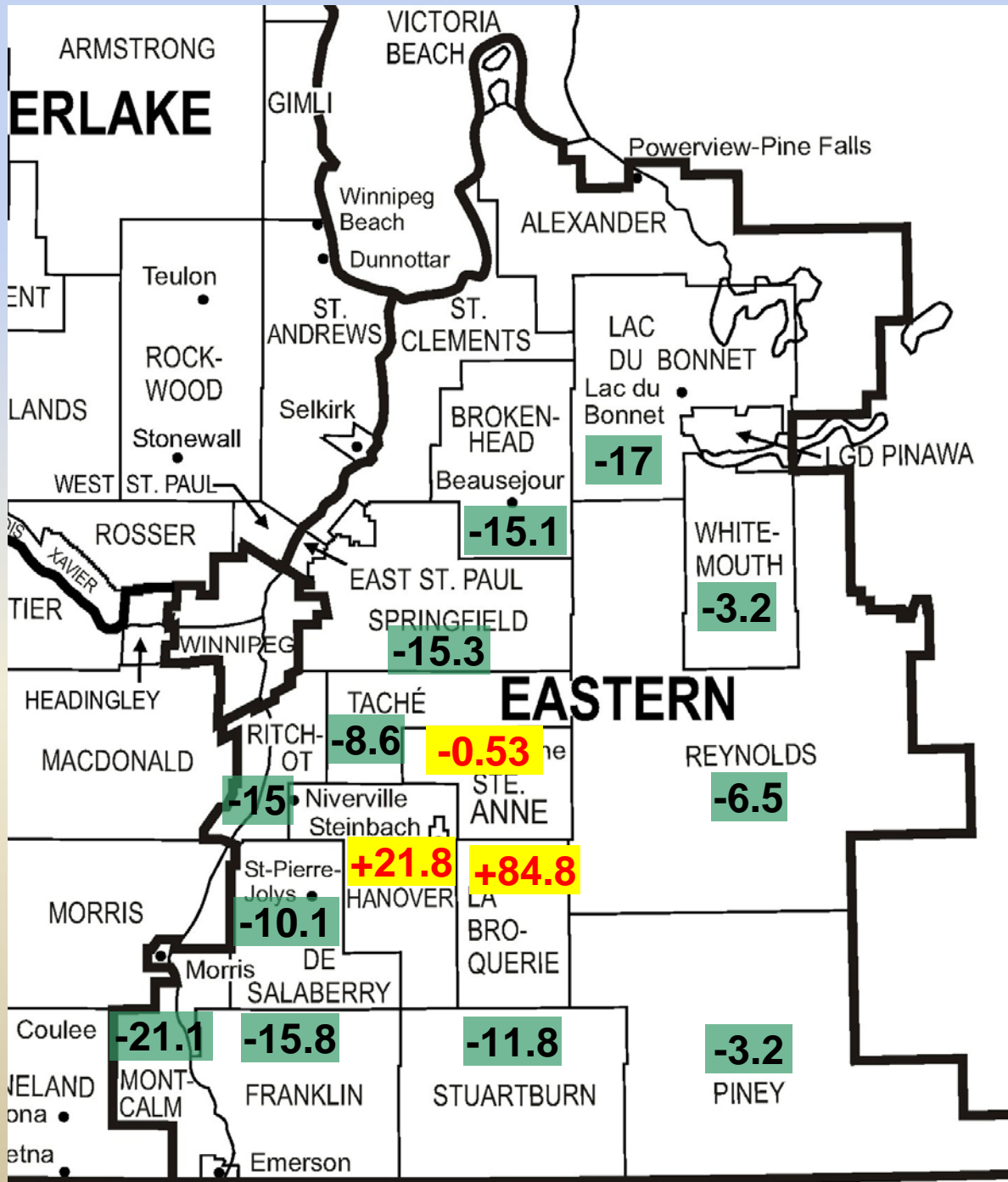


- Manitoba crops remove ~100,000 T  $P_2O_5$  per year
  - ~ 100,000 T  $P_2O_5$  applied as synthetic P fertilizer
  - ~ 17,000 T  $P_2O_5$  applied as livestock manure from all species, including ~ 5000-7000 T  $P_2O_5$  applied as pig manure
- Value of manure P ~ \$25 million/yr

# **A Phosphorus Based Approach to Examining Manitoba's Hog Manure Challenge/Opportunity**

**Collin Gyles and Derek Brewin  
Dept. of Agribusiness and Agric. Economics  
Univ. of Manitoba**

- **manure supply and demand model used to estimate P-based sustainable hog numbers and manure hauling distances for all rural municipalities in Manitoba**
- **scenarios based on 2006 Census for livestock (manure P supply) and land use (crop P removal/demand).**
- **manure P surplus of minor concern for most RMs**
- **concerns increase with:**
  - **low manure acceptance rates (for agronomic, social or regulatory reasons)**
  - **low prices for synthetic fertilizer N and P**



# Manure P "Balance"

(lb P<sub>2</sub>O<sub>5</sub>/ac)

- manure P prod'n and crop P removal based on 2006 Census
- assumes 100% acceptance on cropland and no synthetic P fertilizer applied
- in reality, some P surpluses at field, farm and RM scales are larger



# What are the BMP options for reducing manure P surplus?

# Strategies to Reduce Manure P Surplus

Plan for P balance in new & expanding operations and manage for P balance in existing operations:

## 1) Feed Management

- Improve feed efficiency
- Optimize P content of the feed

## 2) Crop and Land Management

- Reduce import of synthetic fertilizer P
- Maximize crop removal of P
- Expand land base for manure application

## 3) Manure Management and Treatment

- P removal from liquid manure?
- Composting solid manure?

# Summary and Conclusions

- **Balancing manure P application and removal will be a big challenge for some livestock producers**
- **U of M and various partners are working to improve integrated P management in livestock and crop production systems**
- **More work is required to develop and implement manure P BMPs that are environmentally effective, technically feasible, and economically affordable**



# Achieving Manure P Balance in Manitoba



- Partnership effort supported by NCLE, MLMMI, MAFRI and the MB Manure Management Advisory Committee
- 3 main questions to answer?
  - What can we do?
    - ... technical options
  - What should we do?
    - ... prioritization
  - How will we do it?
    - ... action plan