Phosphorus RCN

Future Technologies Group

Our work is focused on informing future technologies and strategies.

Brooke Mayer, Larry Baker, Treavor Boyer, Katrina Macintosh, Rich McDowell, John McGrath, Jim Mihelcic, Steve Powers, Bruce Rittmann, Celine Vaneeckhaute

@sustainP

Total Value of Phosphorus Recovery

Environmental Science & Technology

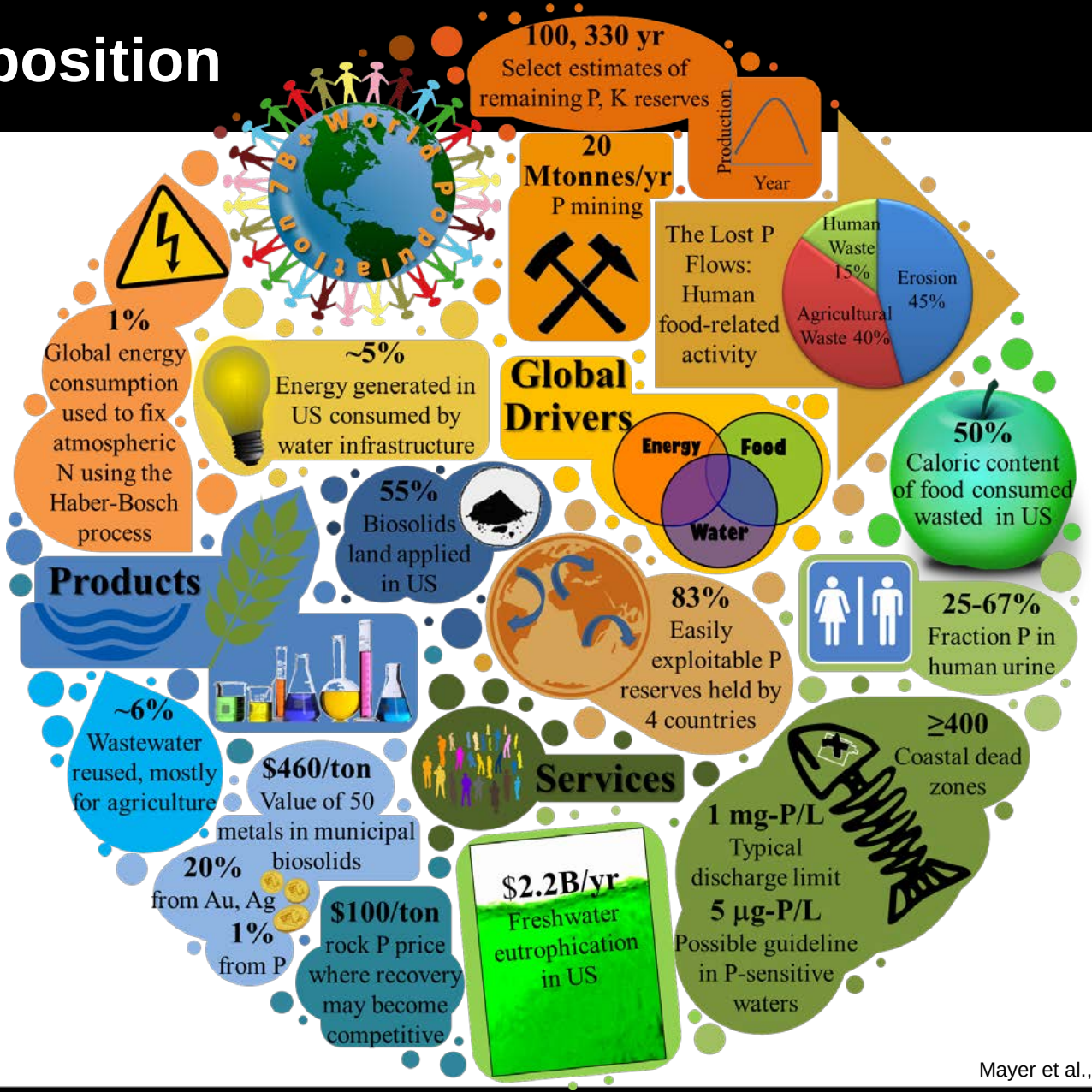
Brooke K. Mayer, Lawrence A. Baker, Treavor H. Boyer, Pay Drechsel, Mac Gifford, Munir A. Hanjra, Prathap Parameswaran, Jared Stoltzfus, Paul Westerhoff, Bruce E. Rittmann

(2016, 50, 6606-6620,
DOI: 10.1021/acs.est.6b01239)

Total Value Proposition

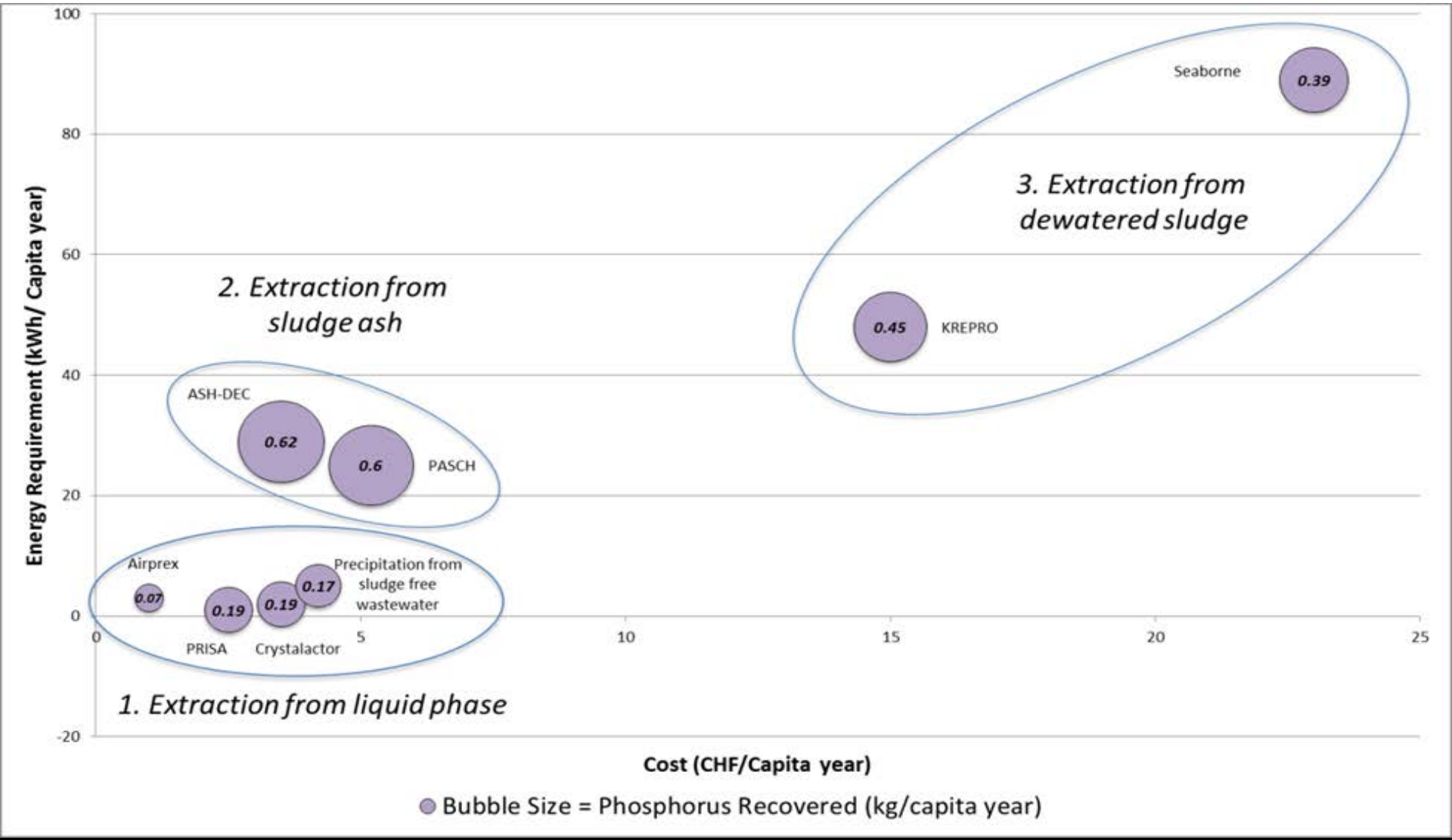
Major global drivers for P recovery and reuse.

Incentives emerge when accounting for total value recovery, including key **[co]products** and **services**



Mayer et al., 2016

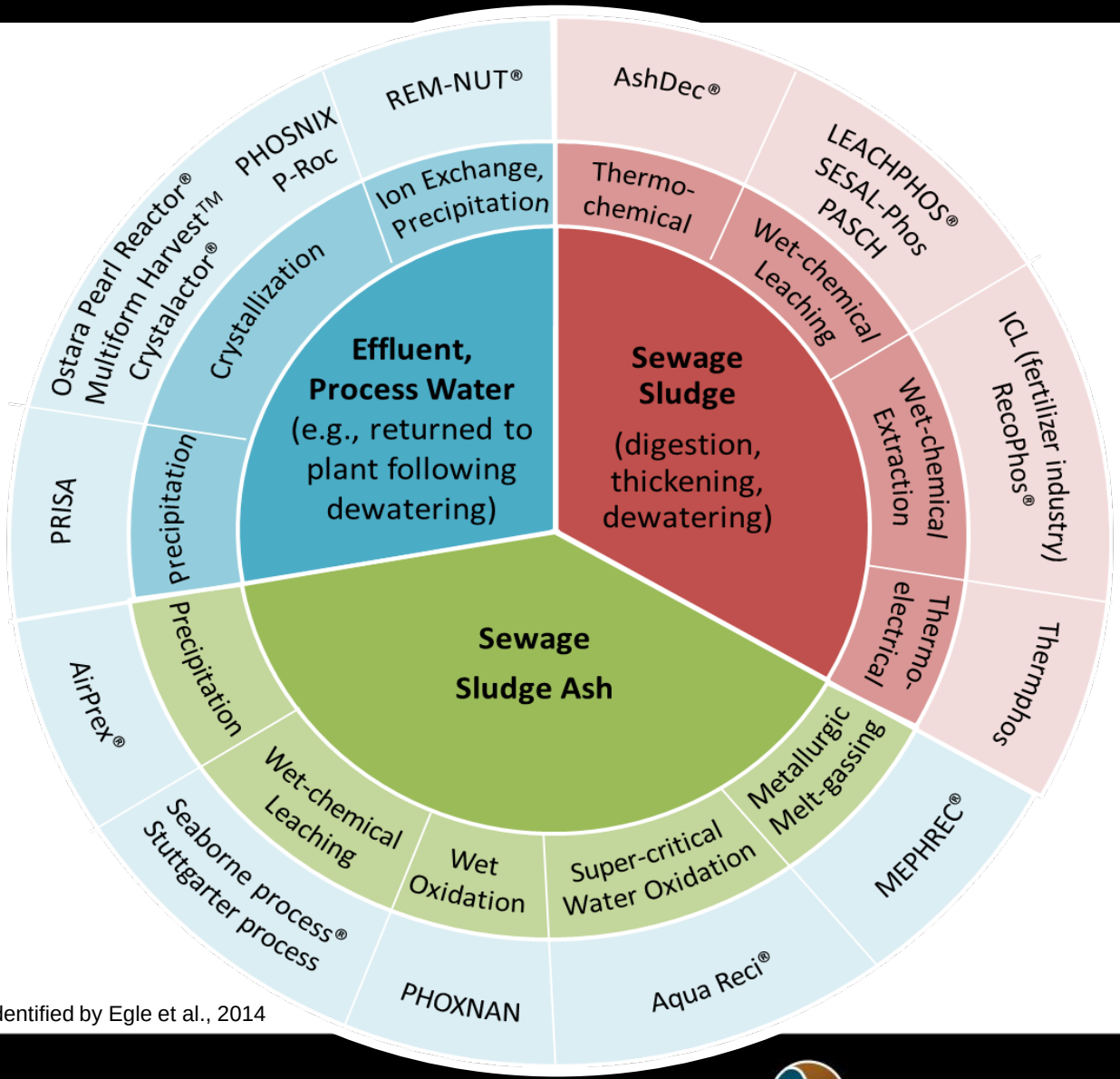
P Recovery Technologies: Energy Versus Cost



Mayer et al., 2016; modified after Morf and Koch, 2009

Sustainable Phosphorus Alliance

Examples of P Recovery Technologies for Wastewater

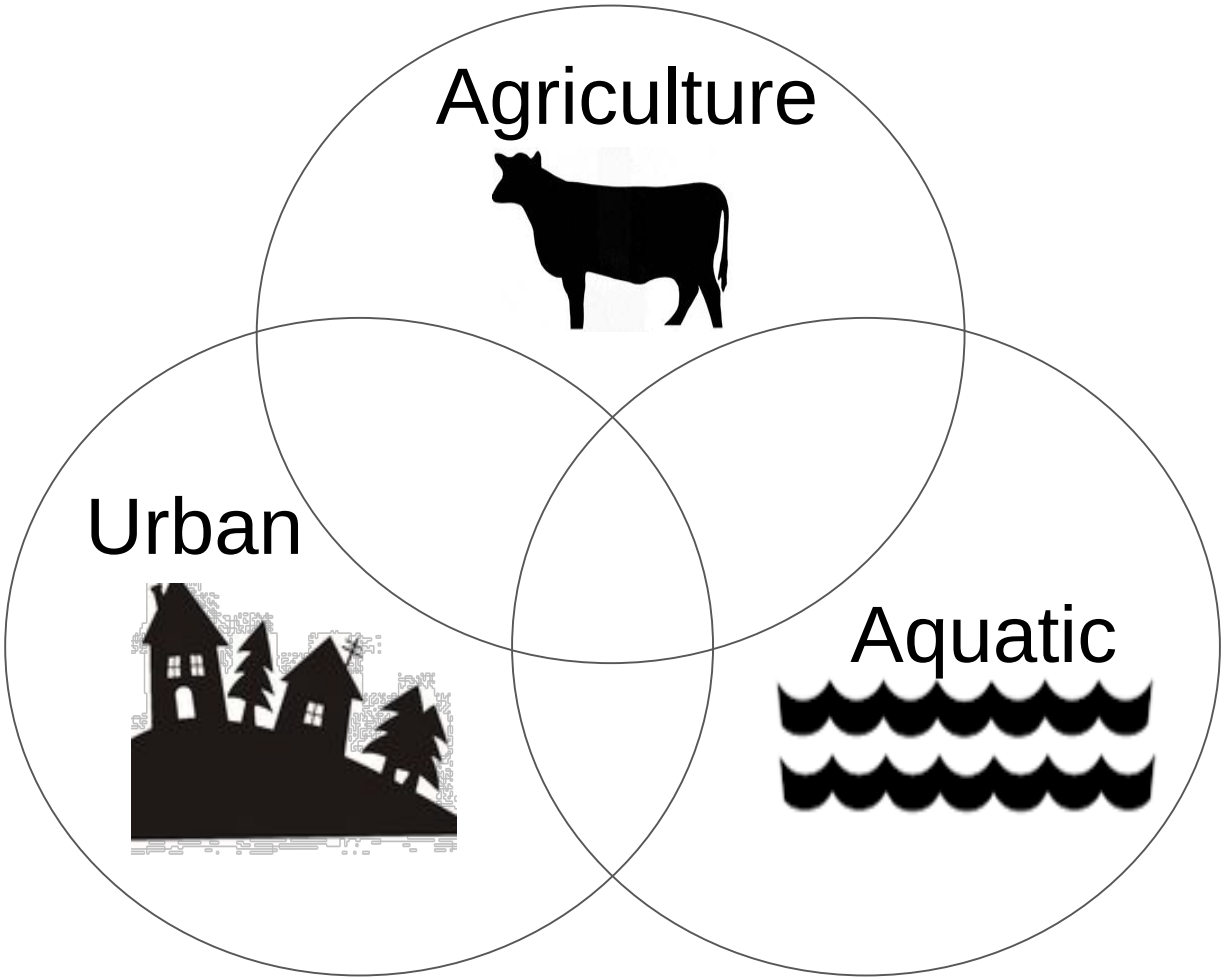


Mayer et al., 2016; identified by Egle et al., 2014

Advantageous technology attributes:

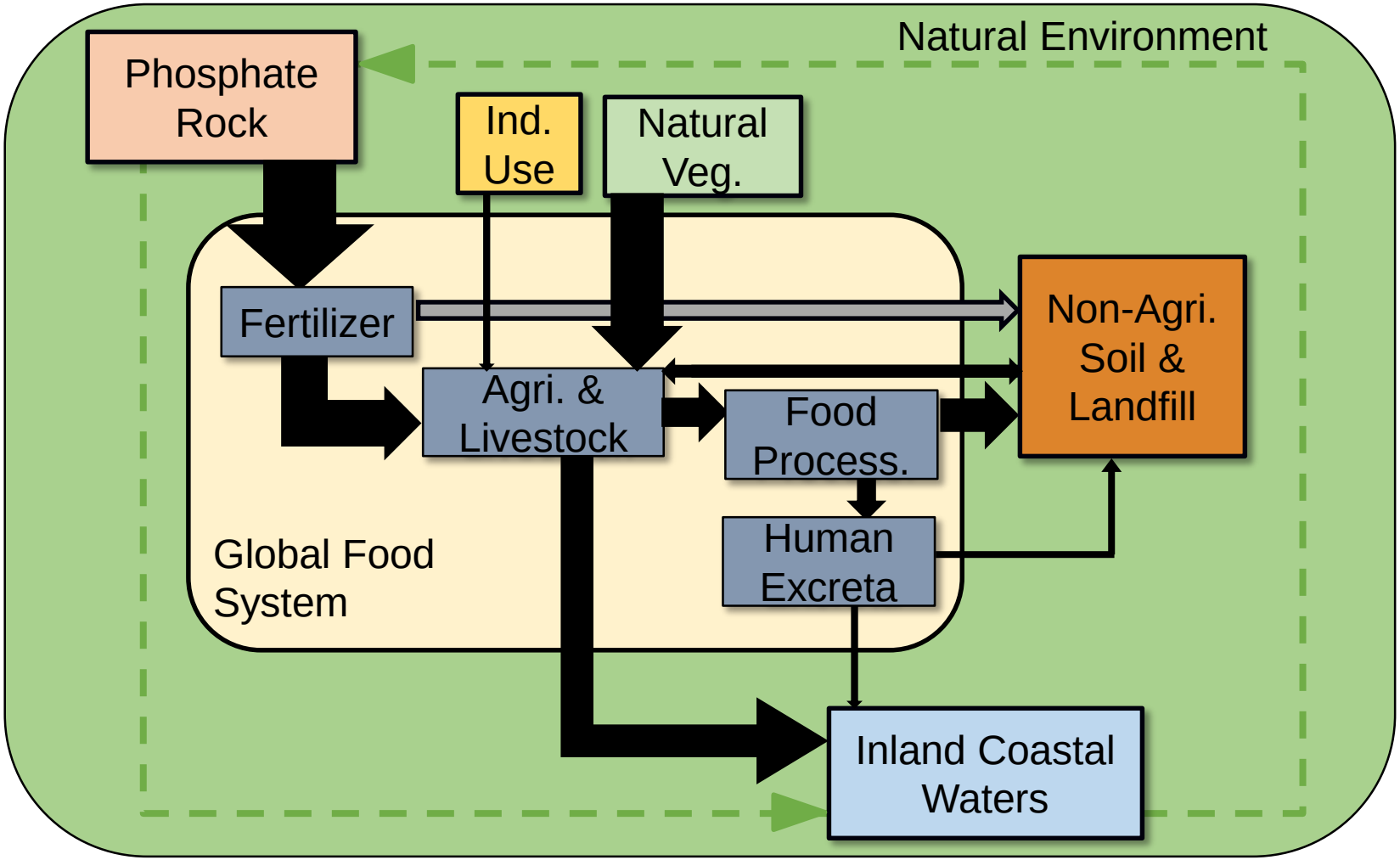
- Co-recovery of other resources
- Reduced costs and inputs of energy and chemicals
- Higher purity products
- Production of readily manageable products
- Locale-appropriate operation

But…what about the rest of the P?



Boyer, Macintosh, Powers, SPA Webinar, 2017

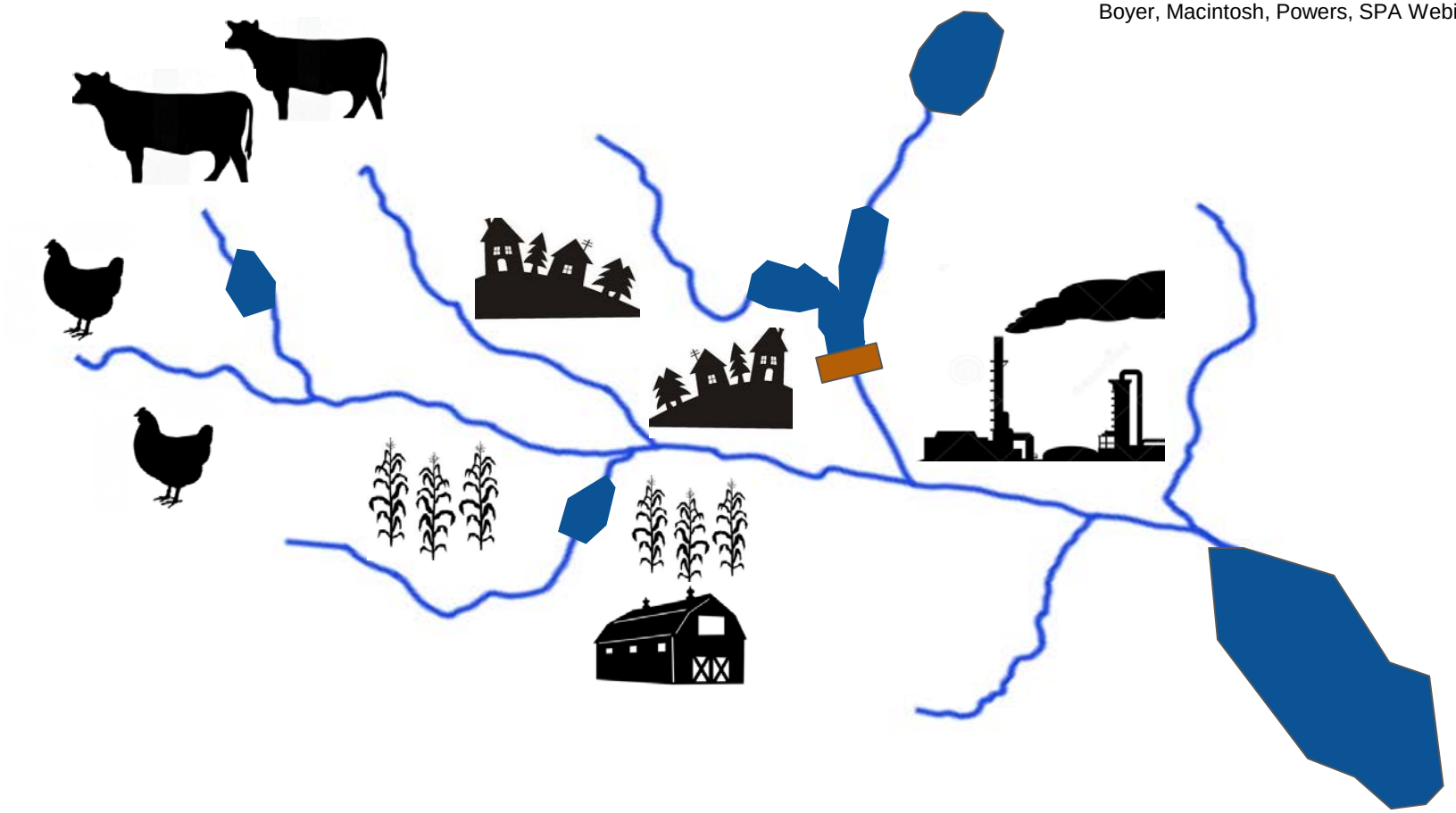
Where is the P?



Modified after Cordell & White, 2014

Approaches for Effective P Management

Boyer, Macintosh, Powers, SPA Webinar, 2017



<u>Overarching goal</u>: Provide information for decision makers and technology developers to identify opportunities for P management in variable systems.

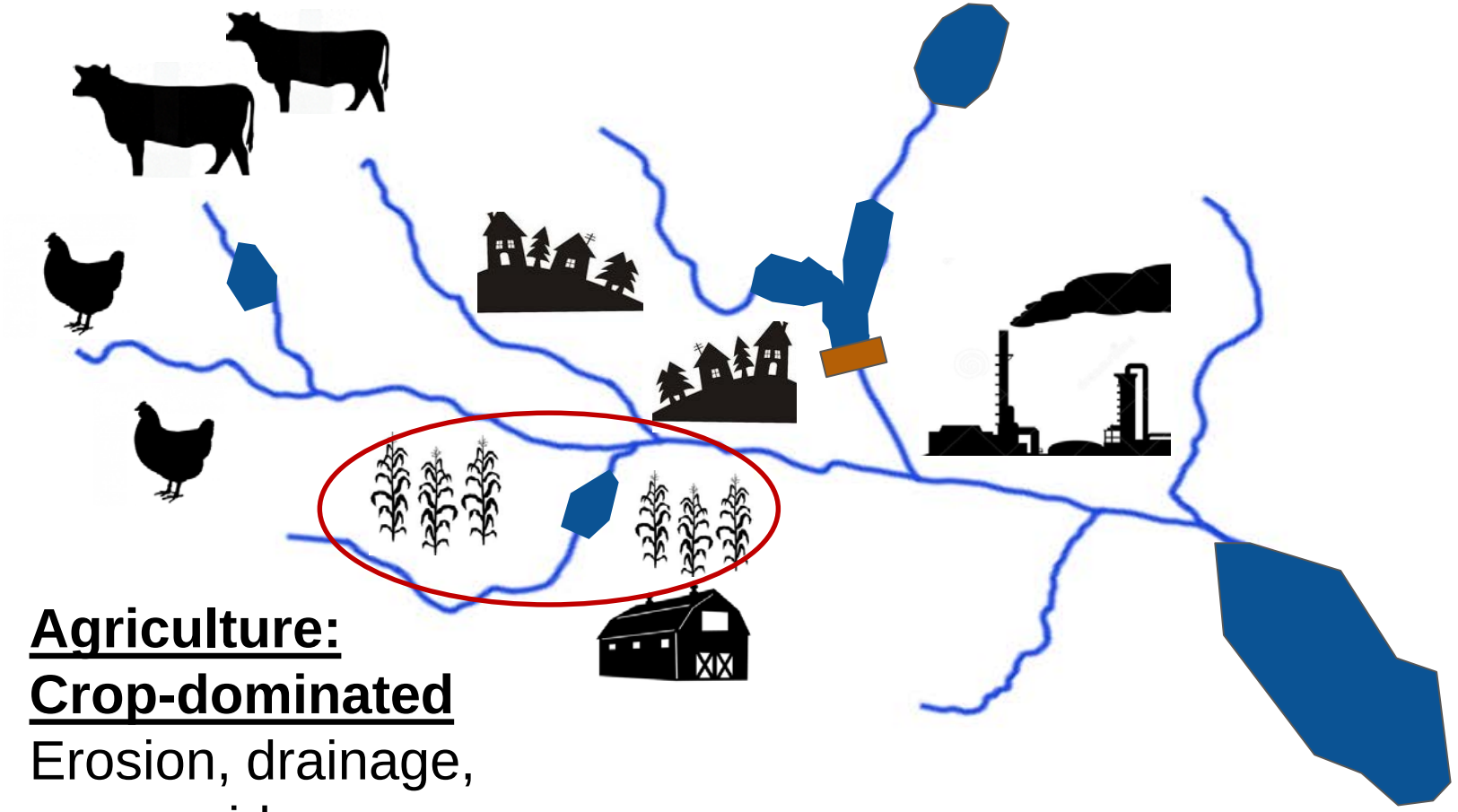
Key Questions

1) How do P **QUANTITY** and **FORM** vary in diverse systems: agriculture, urban, and aquatic?

2) What **MANAGEMENT OPTIONS** and **TECHNOLOGIES** are there to assist in removing and/or recovering P from these systems?
    1) When is it appropriate to manage P at the **SOURCE** or **SINK**?
    2) What are the likely costs/trade-offs and consequences?

Approaches for Effective P Management

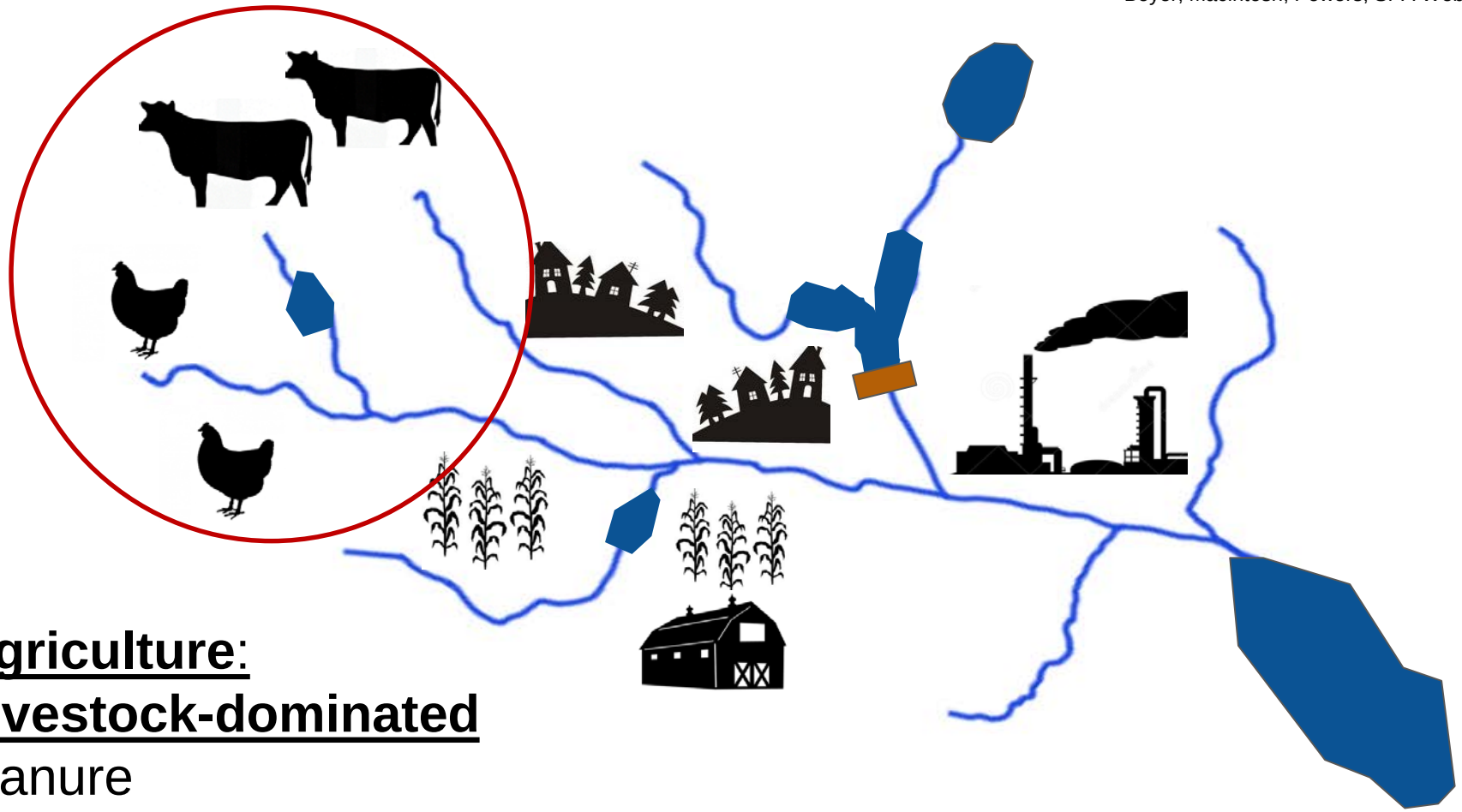
Boyer, Macintosh, Powers, SPA Webinar, 2017



Agriculture:
Crop-dominated
Erosion, drainage, crop residue

Approaches for Effective P Management

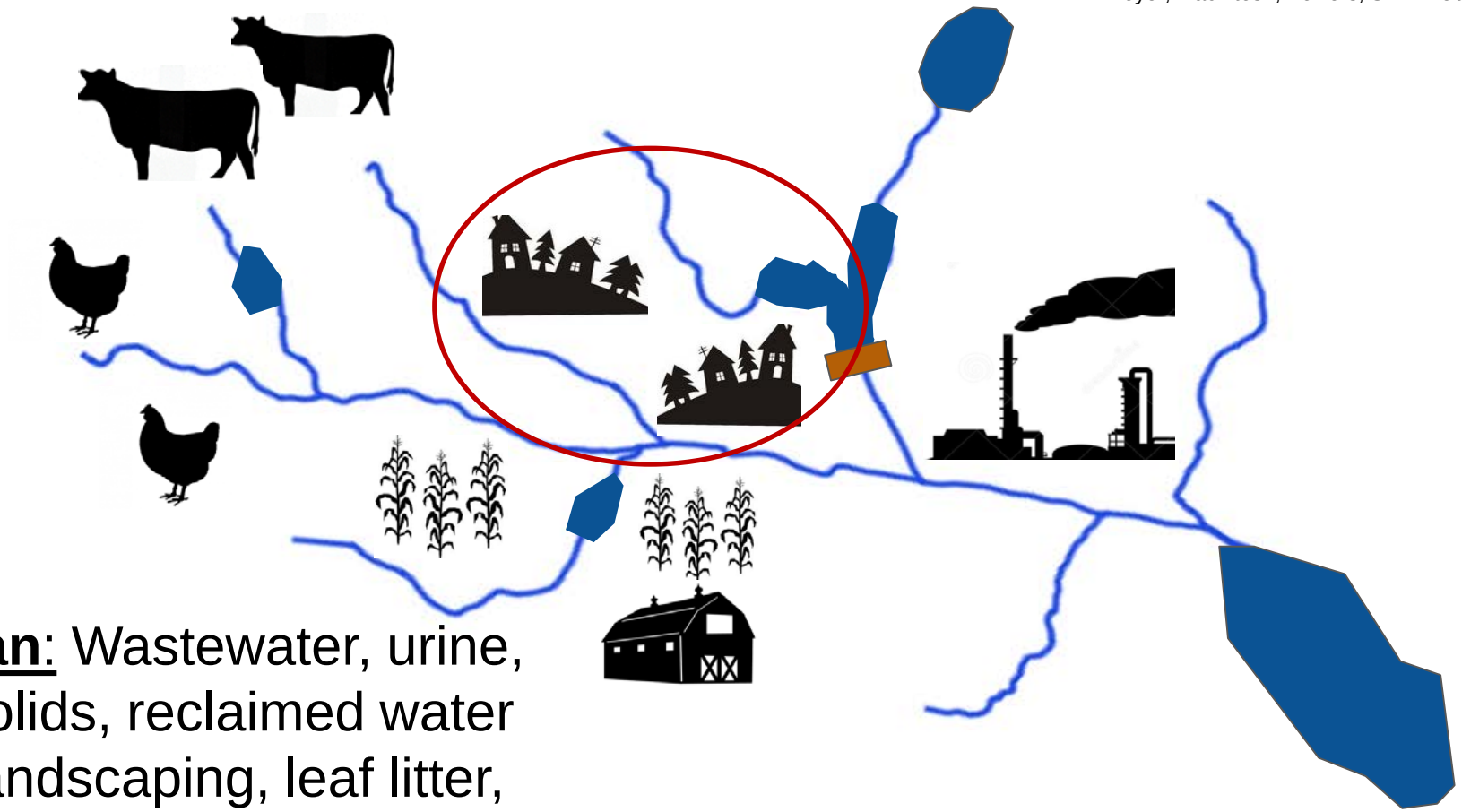
Boyer, Macintosh, Powers, SPA Webinar, 2017



<u>Agriculture</u>:
<u>Livestock-dominated</u>
Manure

Approaches for Effective P Management

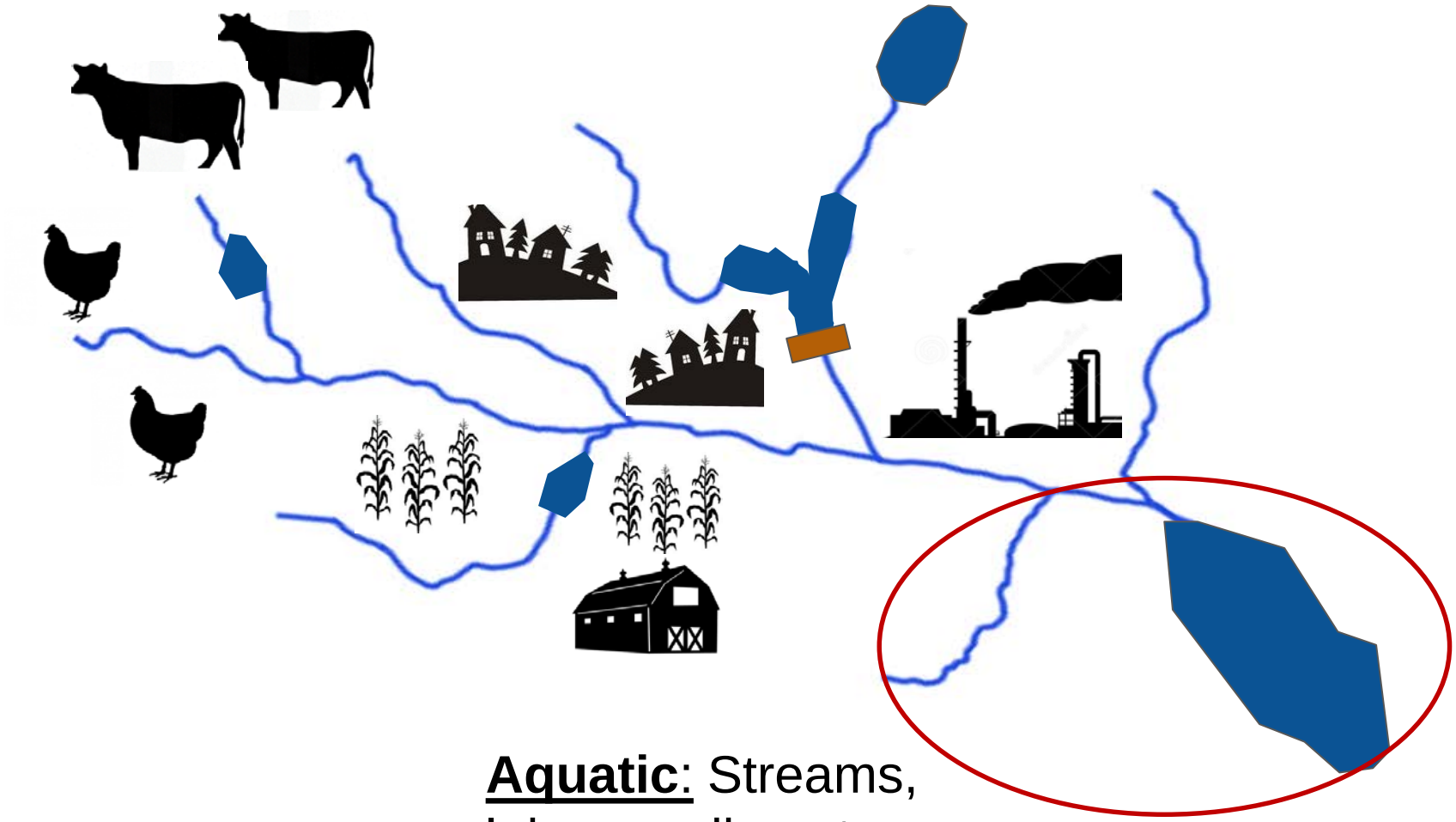
Boyer, Macintosh, Powers, SPA Webinar, 2017



Urban: Wastewater, urine, biosolids, reclaimed water for landscaping, leaf litter, yard waste, pet waste, food waste, landfill leachate

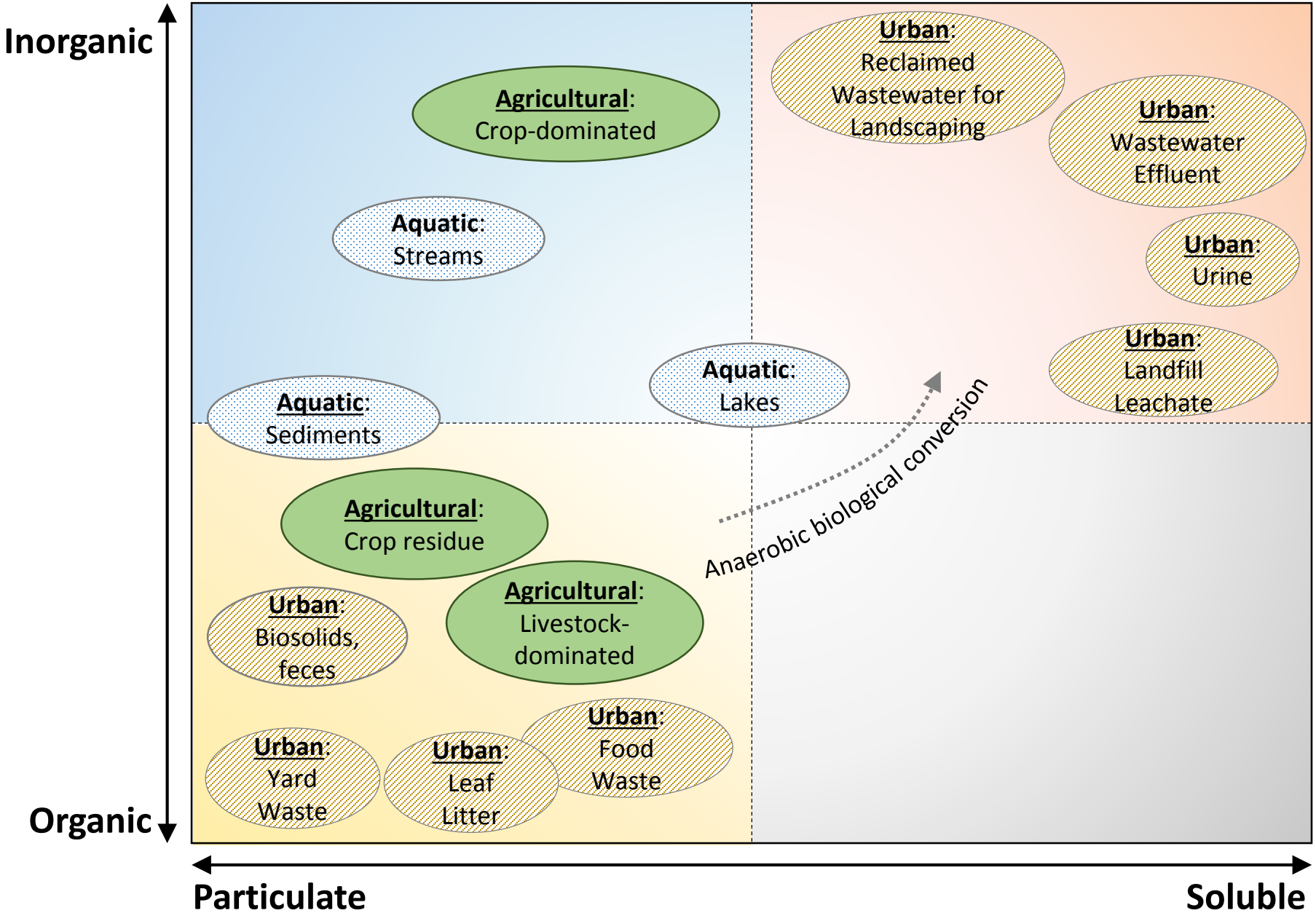
Approaches for Effective P Management

Boyer, Macintosh, Powers, SPA Webinar, 2017



Aquatic: Streams, lakes, sediments

1) How do P **QUANTITY** and **FORM** vary in diverse systems: agriculture, urban, and aquatic?



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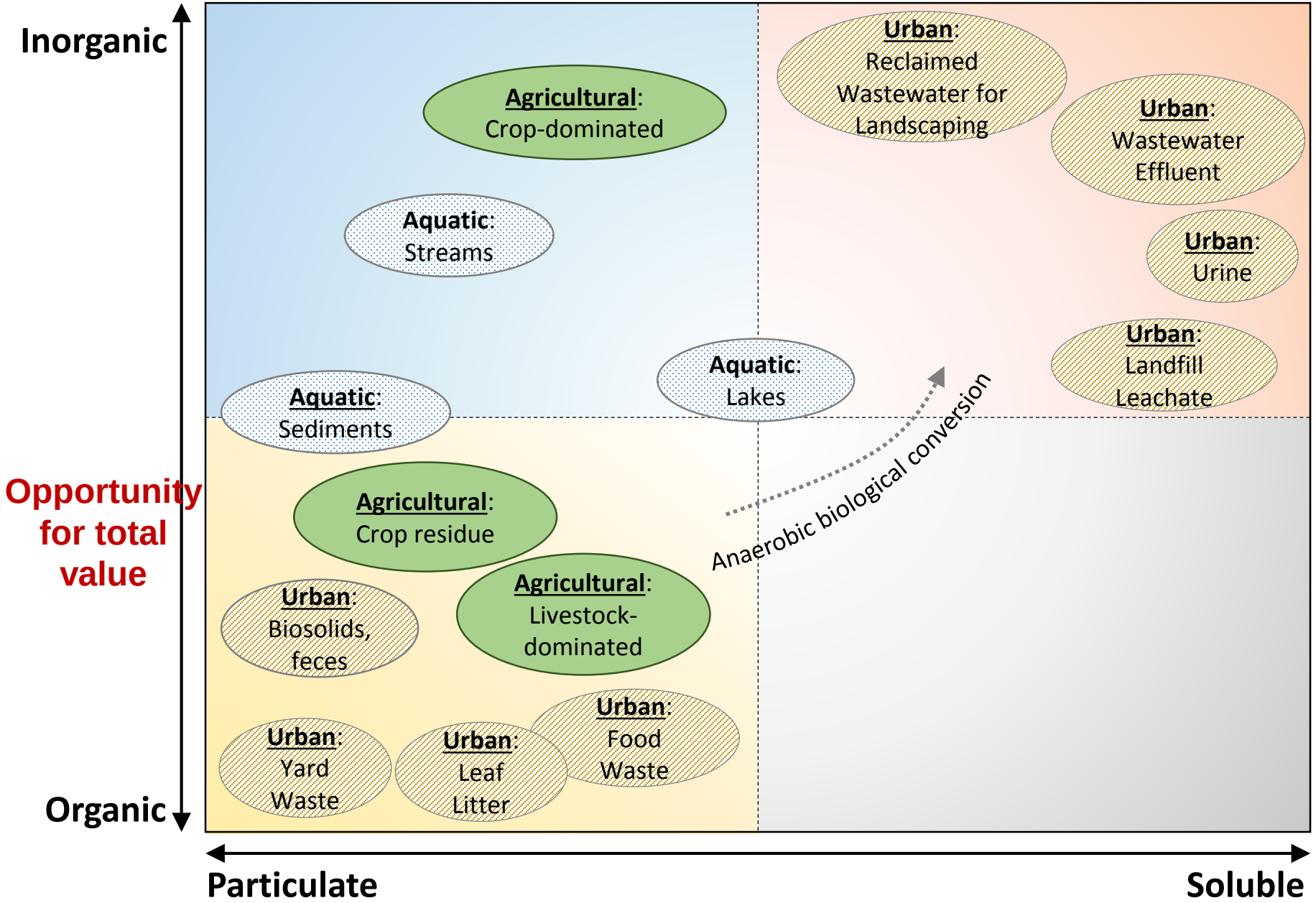

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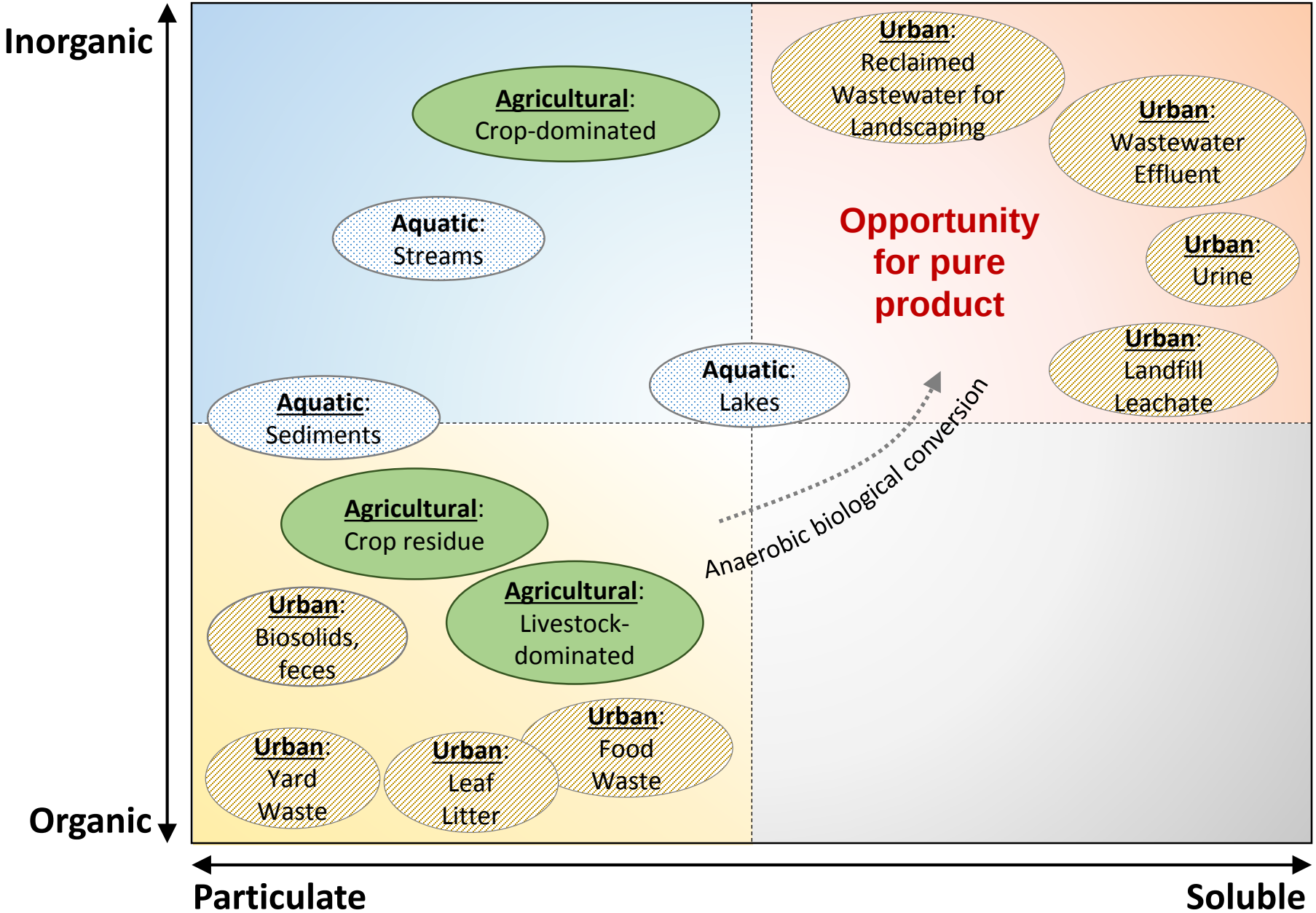

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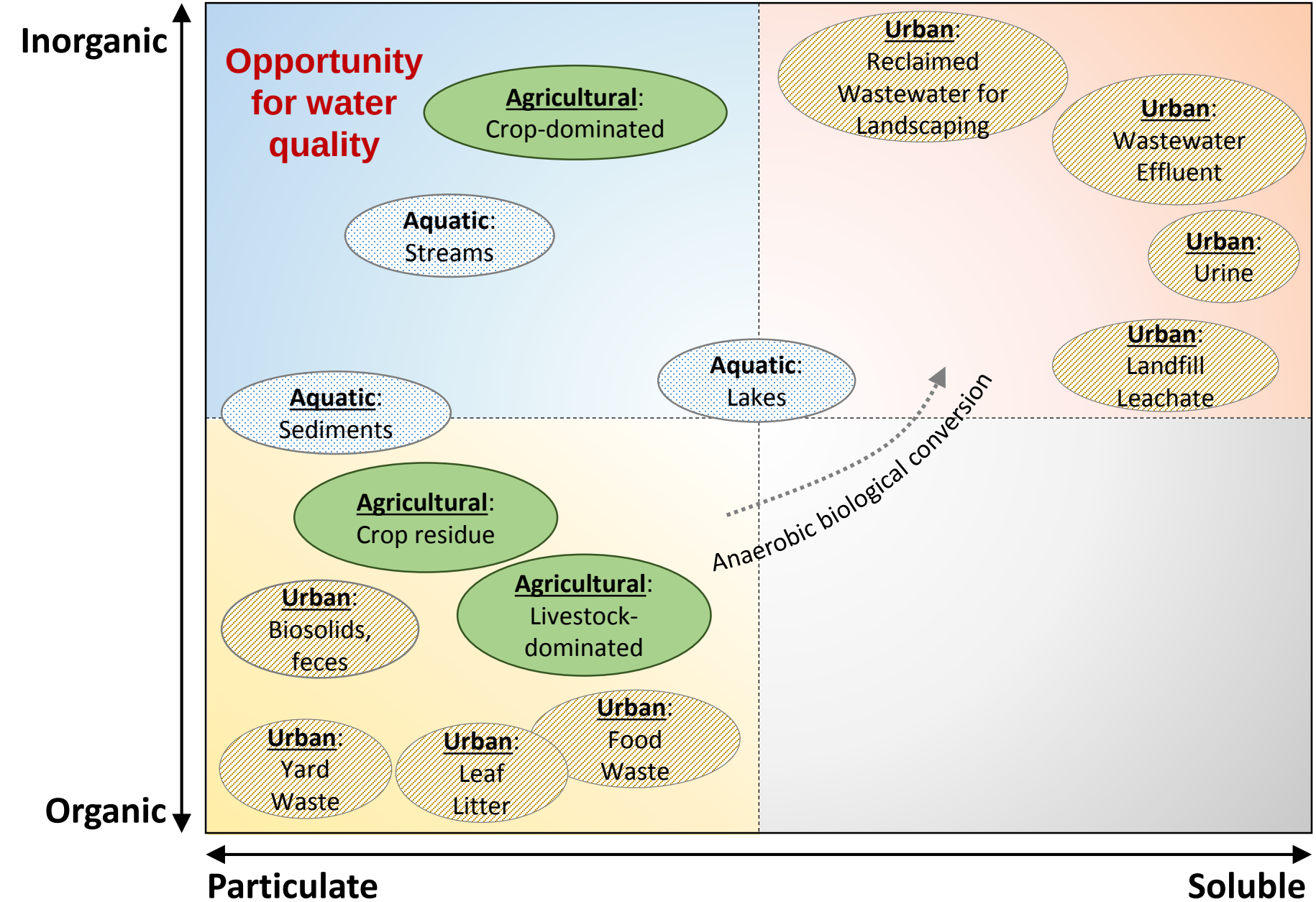
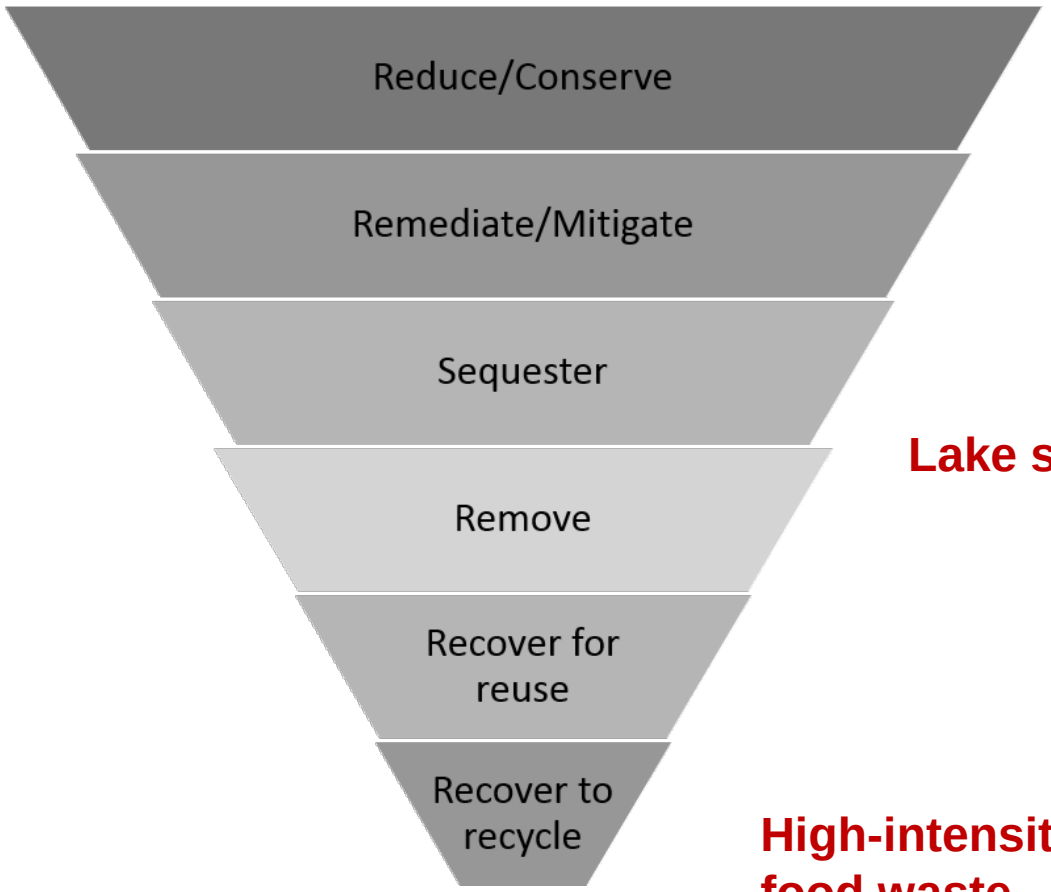


2) What **MANAGEMENT OPTIONS** and **TECHNOLOGIES** are there to assist in removing and/or recovering P from these systems?



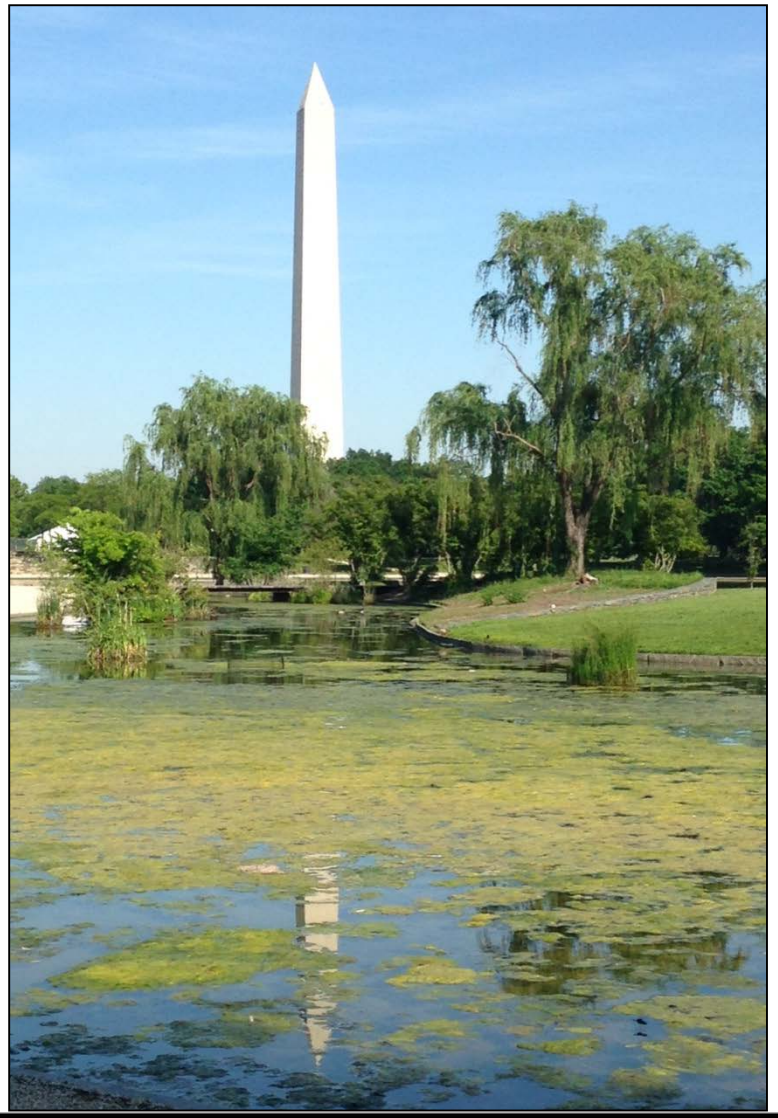
Farm, landscape fertilization

Lake sediments

High-intensity animal operations, food waste

Closing Thoughts on Effective P Management

- Total value proposition
  - Environmental, economic, social considerations
- Opportunities to get the biggest return on investment
  - Protecting water quality
  - Developing new technologies



Opportunities