Nutrients and Harmful Algal Blooms: Effects on Lakes and Lake Users

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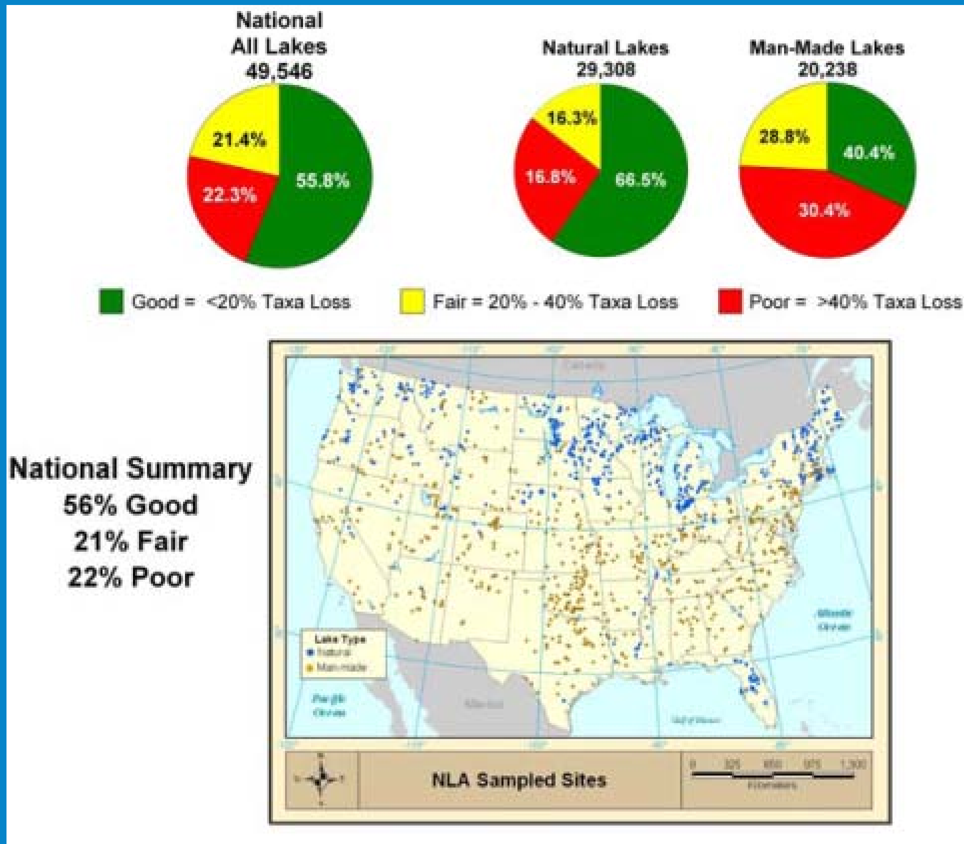
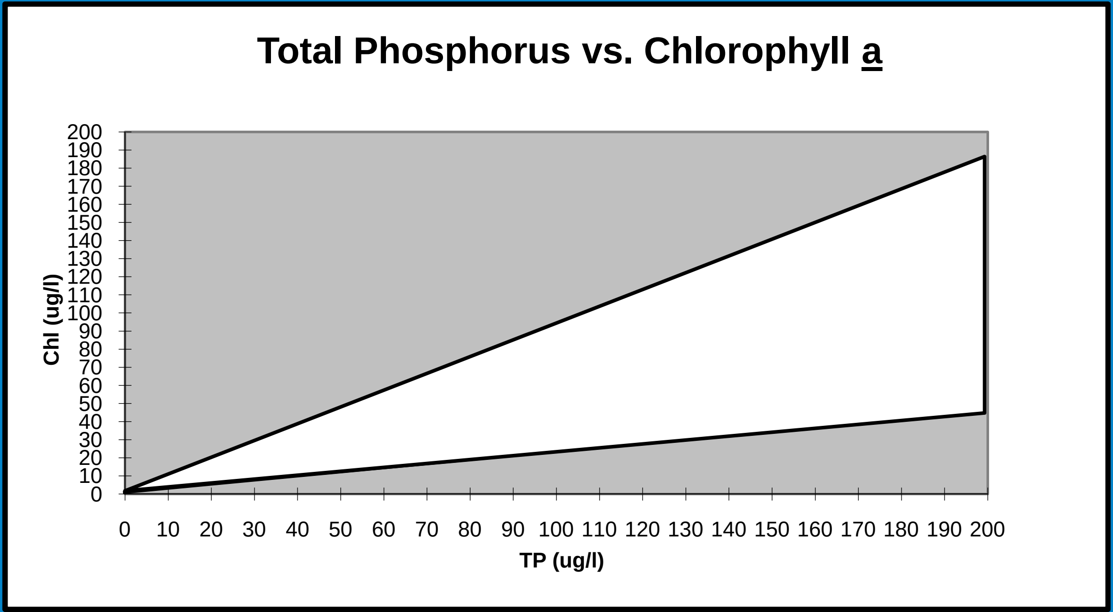
Water Resource Services

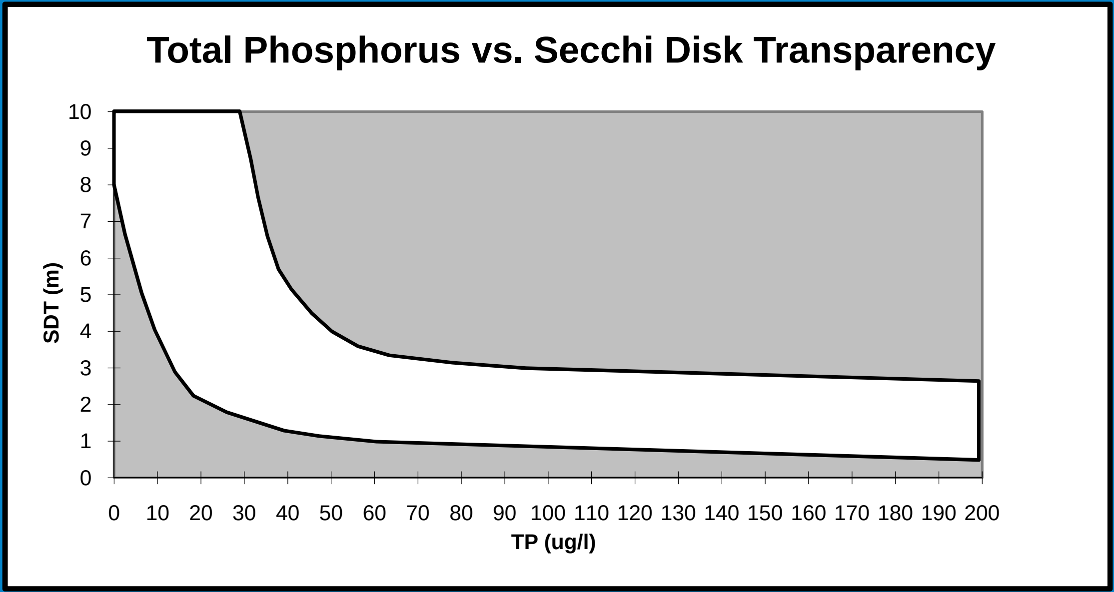
Why are nutrients a concern?



According to the NLAP study, almost half of our nation's lakes are in less than good shape as a consequence of nutrient pollution. Nutrients have a positive connotation in health, but overabundance of nutrients can lead to overfertility in lakes (i.e., "fat" lakes).

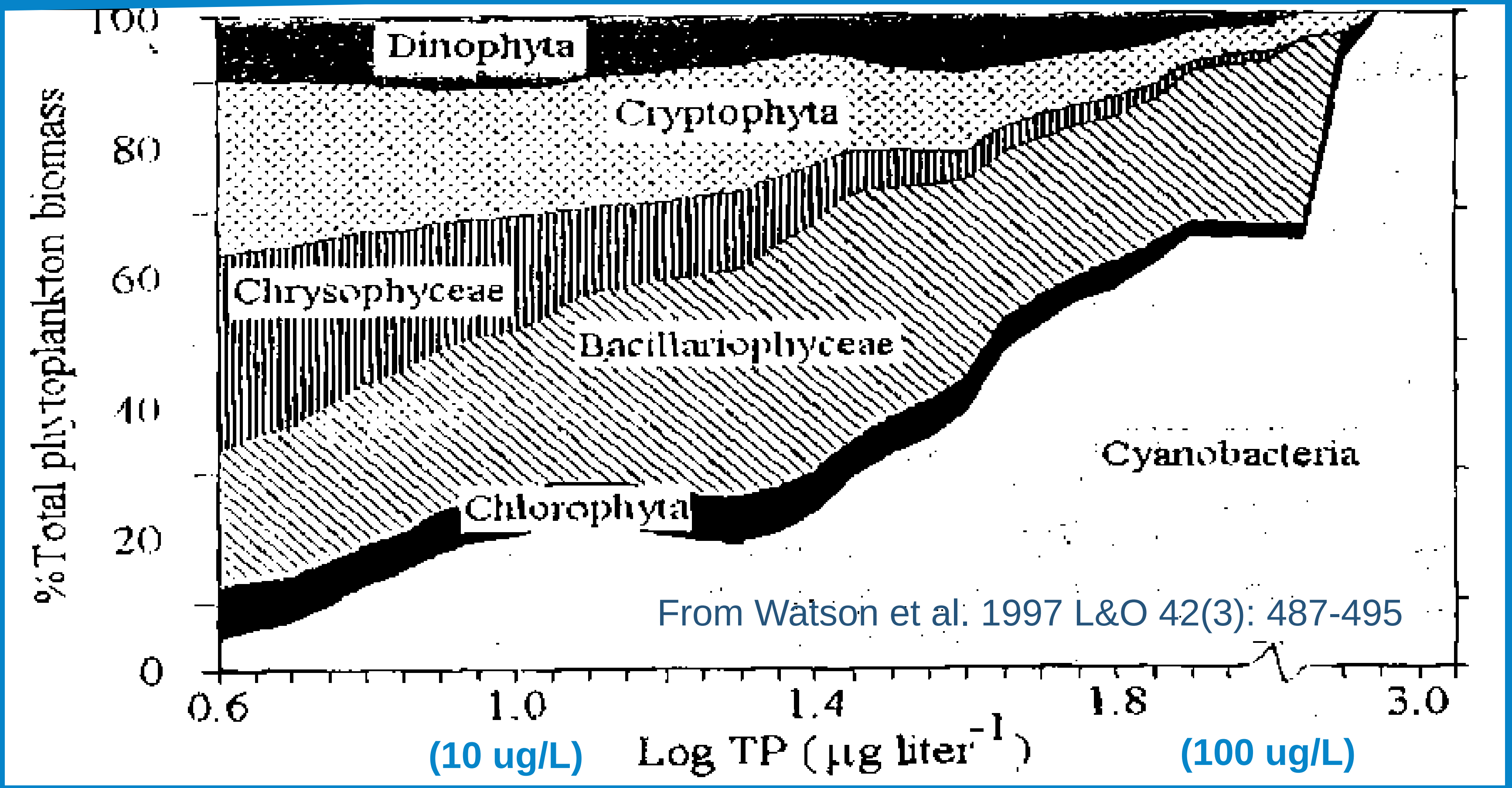
The impact of phosphorus





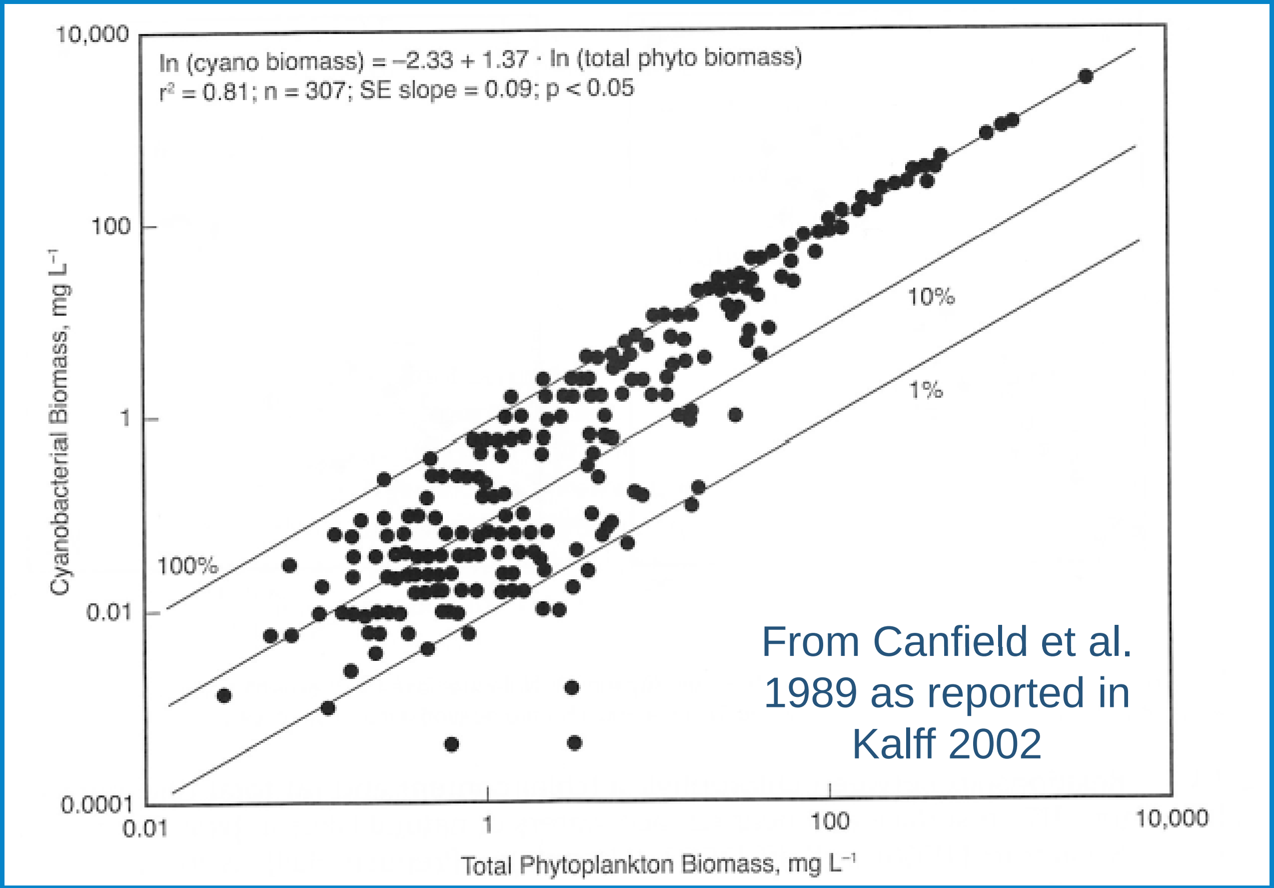
- Based on decades of study, more P leads to more algae
- More algae leads to lower water clarity, but in a non-linear pattern

The impact of phosphorus



– High P also leads to more cyanobacteria, from considerable empirical research. Key transition range is between 10 and 100 ug/L

The impact of phosphorus



– As algal biomass rises, a greater % of that biomass is cyanobacteria. So more P = more algae = more cyanobacteria.

Don't ignore nitrogen!

- N and P tend to co-vary, so increased N also results in increased algal abundance
- N:P ratio often determines which algae are dominant; lower N:P leads to more cyanobacteria, as many cyanobacteria can use dissolved N gas, unique to this group

Cyanotoxins

- May be liver, nerve or skin toxins
- Selectively produced by many genera, but not very predictable
- Widely distributed, but not often at acutely toxic levels

Cyanotoxins

- Some other algae produce toxins - Prymnesium, or golden blossom, can kill fish; marine dinoflagellates, or red tides, can be toxic to many animals and humans.
- Cyanobacteria are the primary toxin threats to people from freshwater; acute toxicity is rare, but chronic effects may be significant and are difficult to detect.
- Research (e.g., 3 papers in Lake and Reservoir Management in September 2009) indicates widespread occurrence of toxins but highly variable concentrations, even within lakes.
- Water treatment in typical supply facilities is adequate to minimize risk; the greatest risk is from substandard treatment systems and direct recreational contact.

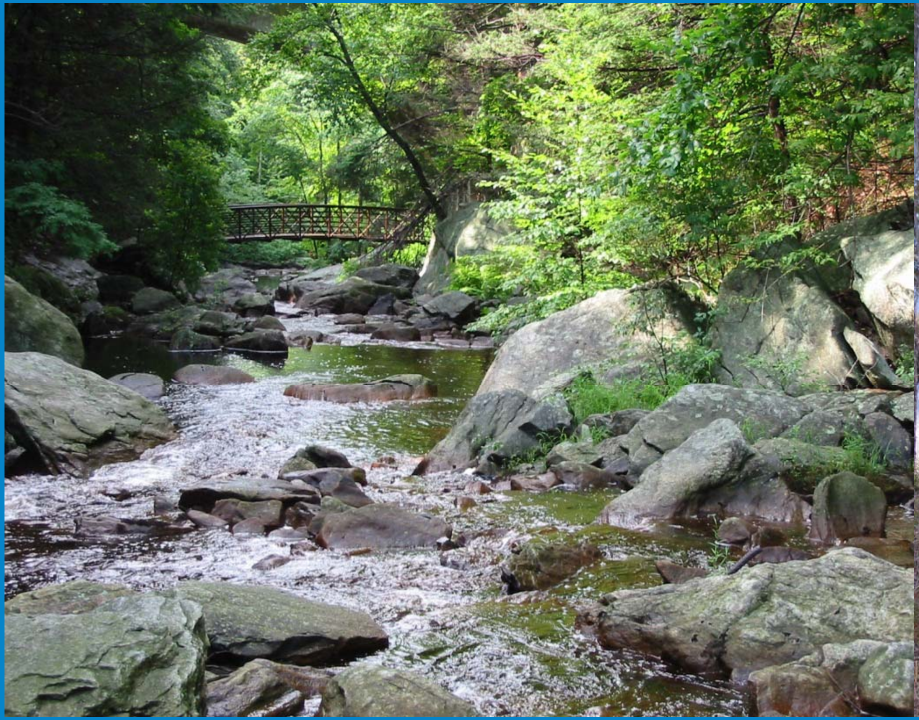
Sources of nutrients

- Natural background: P that falls from the sky, dissociates from soil or is released from decaying vegetation, also P in manure from wild animals
- Fecal material: Inadequately treated human or domestic/farm animal wastes
- Fertilizers: Improperly applied or poorly retained agricultural or residential growth enhancing materials
- Stormwater runoff: Not an actual source, but conveyance linked to impervious surfaces and inadequate buffer zones
- Internal recycling: “The ghost of loadings past”, nutrients that come back out of the sediments by multiple mechanisms and become available again.

Magnitude of nutrient loads

– Very desirable TP: <10 ug/L; Poor: >100 ug/L

– Background P concentrations = 5-50 ug/L typical, variation with geography and related soils and water chemistry



Magnitude of nutrient loads

– Urban runoff P concentrations: 50 to 5000 ug/L, median between 370 and 470 ug/L

– Agricultural runoff P concentrations: 30 to 4000 ug/L for crops, feedlots normally exceed 4000 ug/L (can be >100,000 ug/L)

Magnitude of nutrient loads

– Wastewater treatment effluent P: Very best treatment achieves 20 to 50 ug/L; few WWTF achieve better than 1000 ug/L, some as high as 12,000 ug/L

The impact of development

Lake George, NY: 5% developed watershed contributes same P load as remaining undeveloped 95%

Watershops Pond, MA: 75% developed watershed, input P averages 193 ug/L.

The impact of agriculture

Missouri reservoirs in areas with mean crop cover of 25% have mean TP of 58 ug/L (Jones et al. 2009)

Lake Waco watershed in TX has 5% of land in dairy farms, contributing 26% of TP to inlet concentration of 140 ug/L, and over 50% of available P (Wagner 2010)

How do we control nutrient loading?

– Source and Activity Controls - Eliminate or reduce sources which generate pollutants

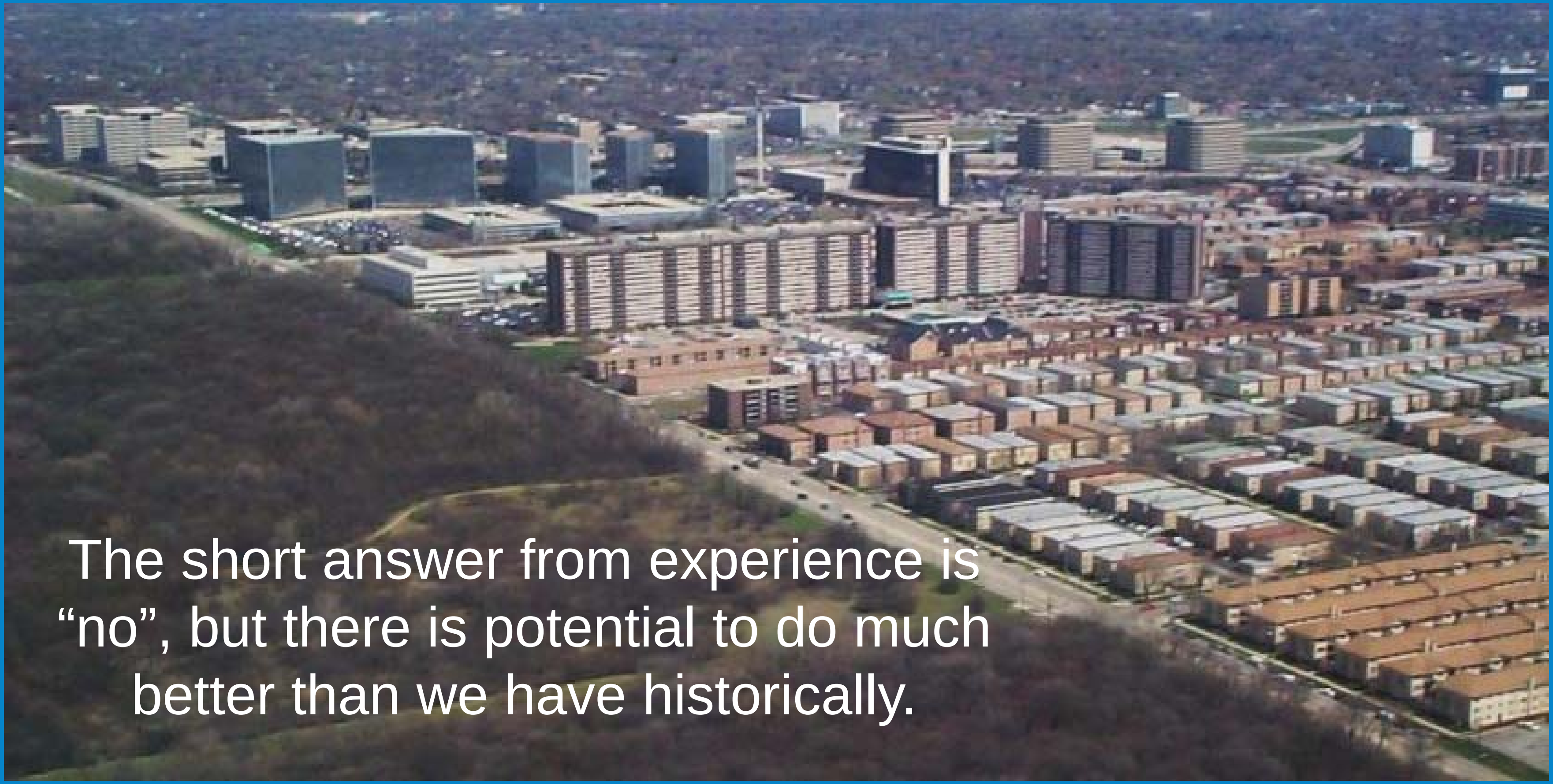
– Transport Reduction - Capture and remove or convert pollutants before they enter target resource

– Instream/Inlake Treatments– enhancing internal processes for pollutant inactivation

– **Ecosystem Rehabilitation- Repair damage to resources when controls fail**

Doing the math on watershed controls

– Can we get the land on the right to act like it is land on the left?



Conclusions

- Increased nutrient loading supports more algal growth with a greater portion of cyanobacteria
- Abundant algae can impair uses, but abundant cyanobacteria represent a distinct health threat as well
- Nutrient loads induced by human activities (development, agriculture, wastewater discharge) are far in excess of natural background levels in most areas