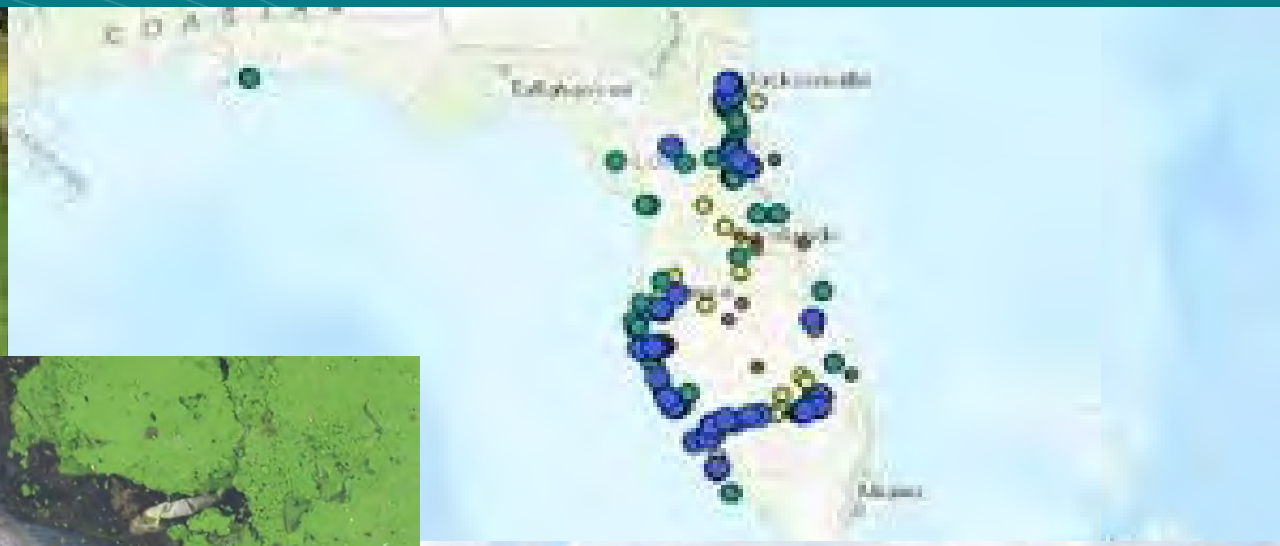
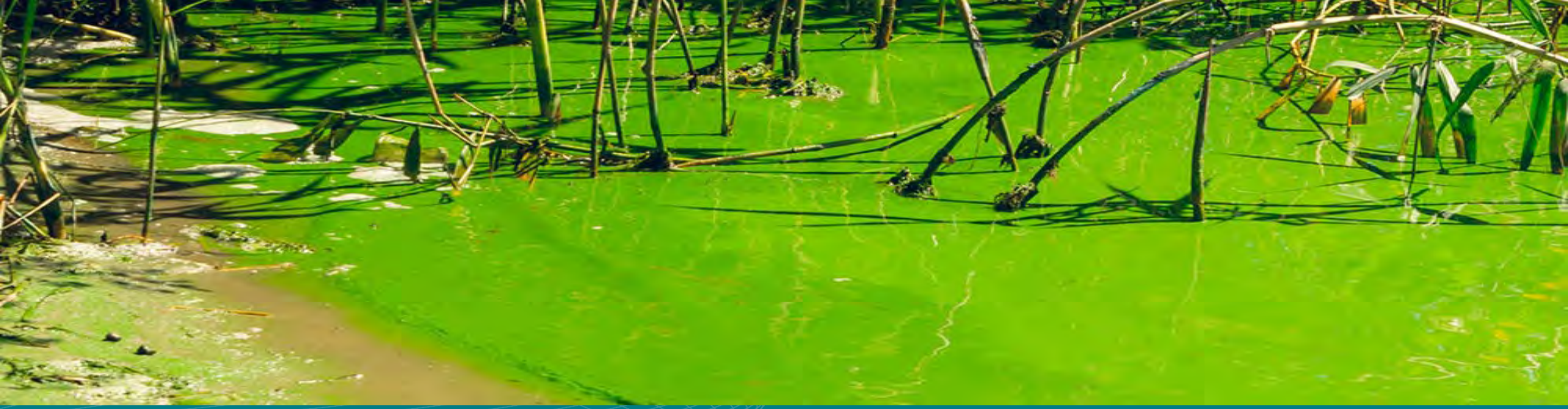
Nutrient Pollution

Hydro International



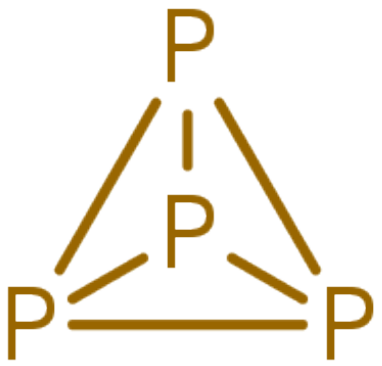


Phosphorus

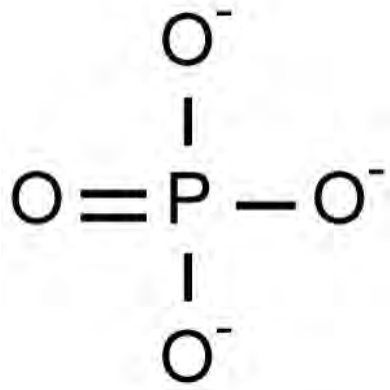
Hydro International

Phosphorus (P_4)

- Elemental phosphorus (P_4) is highly reactive and is never found as a free element on Earth.
- An essential mineral that is required by every living cell
- It is found in our bones and teeth
- **Phosphate** (PO_4^{3-}) is in all biological systems



Phosphorus

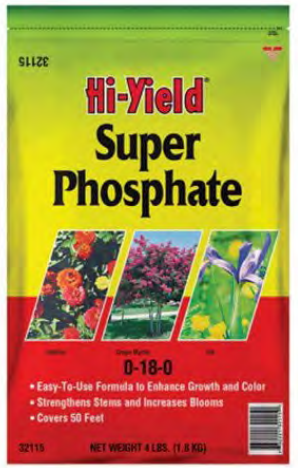


Phosphate

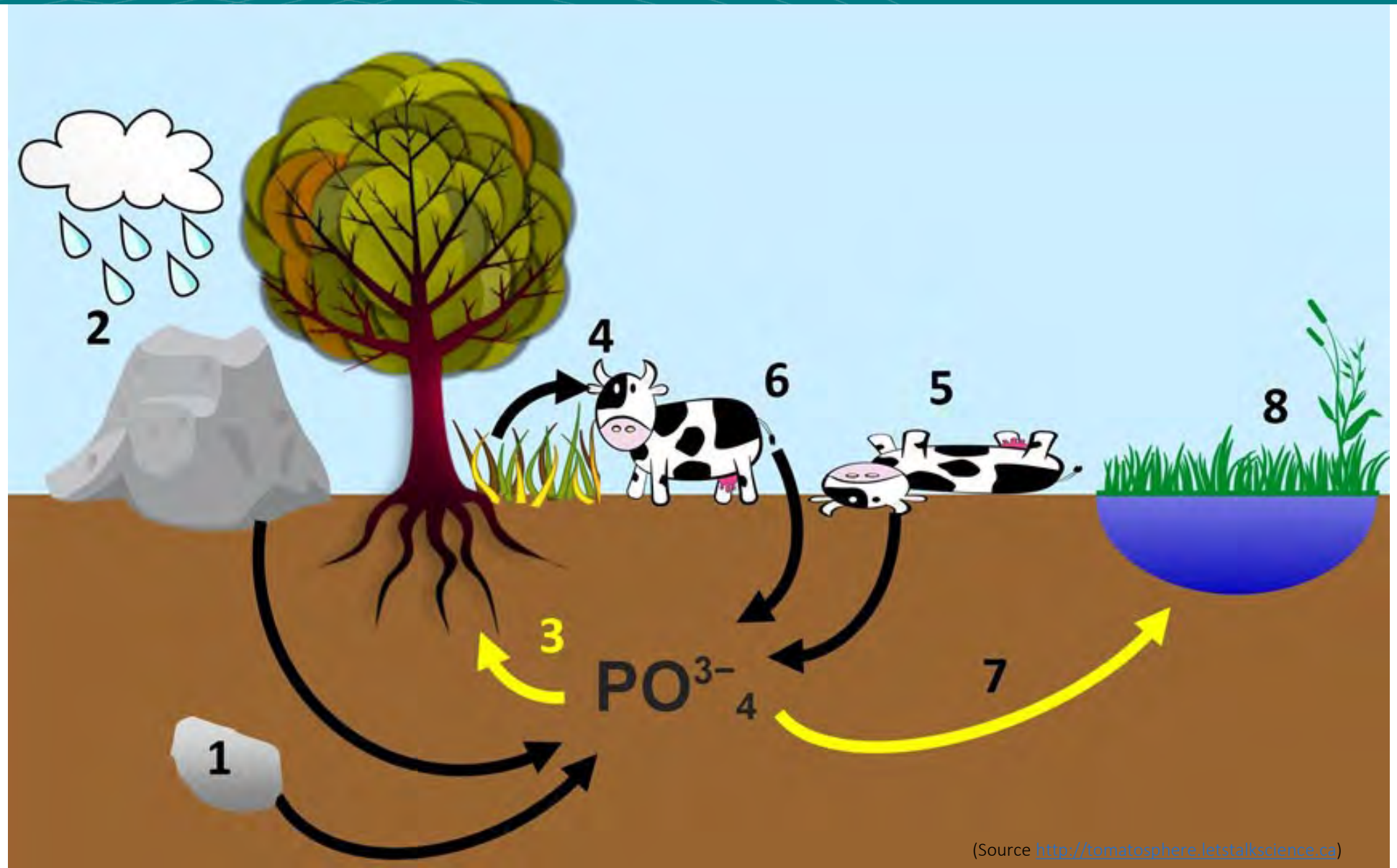
Phosphate (Ortho-phosphate)

- Phosphate (Ortho-phosphate or Reactive Phosphorus)
  - Most biologically available form of phosphorus
  - Required for life but at very low concentrations
  - Occur naturally, and unnaturally as fertilizer

- Most soluble phosphorus in stormwater is in the ortho-phosphate form (PO_4^{3-}) which is the most usable form by plants.



Phosphorus Cycle



(Source http://tomatosphere.letstalkscience.ca)

Total Phosphorous

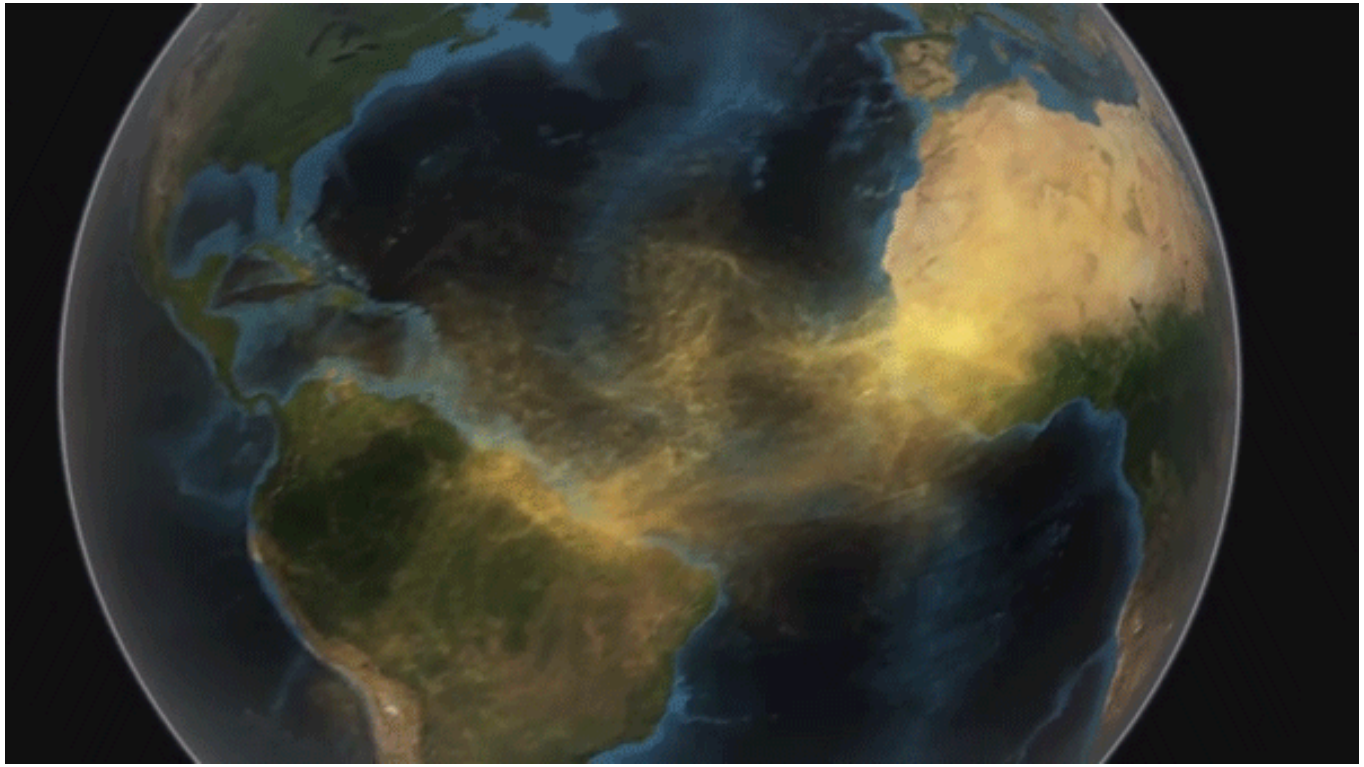
Total Phosphorus (TP) = Particulate Phosphorus + Dissolved Phosphorus

- Total Phosphorus – Primarily transported by surface water

- Particulate phosphorus is primarily composed of bacteria, algae, detritus, zooplankton, and inorganic particulates such as silt and clay.

Fun Fact

- Every year, millions of tons of nutrient-rich Saharan dust cross the Atlantic Ocean, bringing vital **phosphorus** and other fertilizers to depleted **Amazon** soils.



University of Maryland. "Massive amounts of Saharan dust fertilize the Amazon rainforest." ScienceDaily. ScienceDaily, 24 February 2015. www.sciencedaily.com/releases/2015/02/150224102847.htm

Eutrophication & Total Phosphorus

Expected Concentrations:

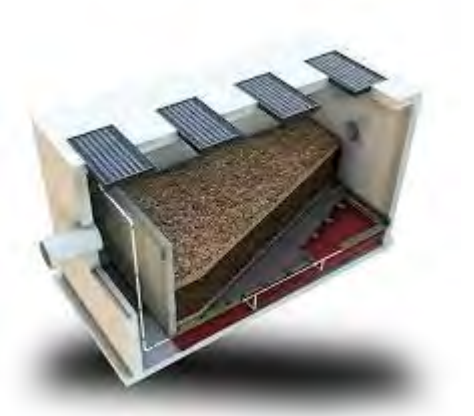
- *0.01 - 0.03 mg/L - the level in uncontaminated lakes*
- *0.025 - 0.1 mg/L - level at which plant growth is stimulated*
- ***0.1 mg/L - maximum acceptable to avoid accelerated eutrophication***
- *> 0.1 mg/L - accelerated growth and consequent problems*

1 mg/L = 1 part per million (1 ppm)= 0.066 gal in 660,253 gals, an Olympic swimming pool

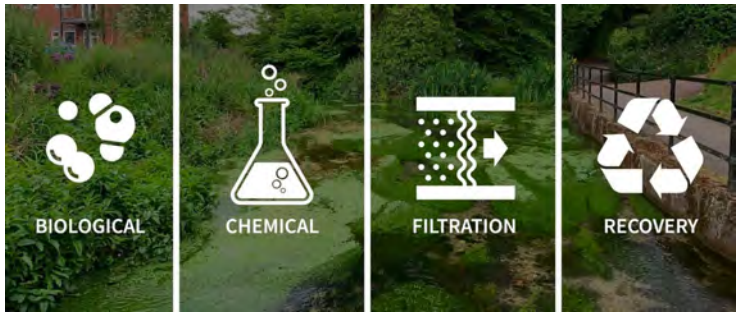
8.448 oz

Treatment - Phosphorus

- Filtering
  - 70% of total phosphorus and phosphate were removed from stormwater through removal of particles with diameter greater than 20 µm (WERF, 2003)
  - Removing particulates down to 5 µm increased removal efficiency to approximately 80%
  - The ratio of dissolved to particulate will impact this.

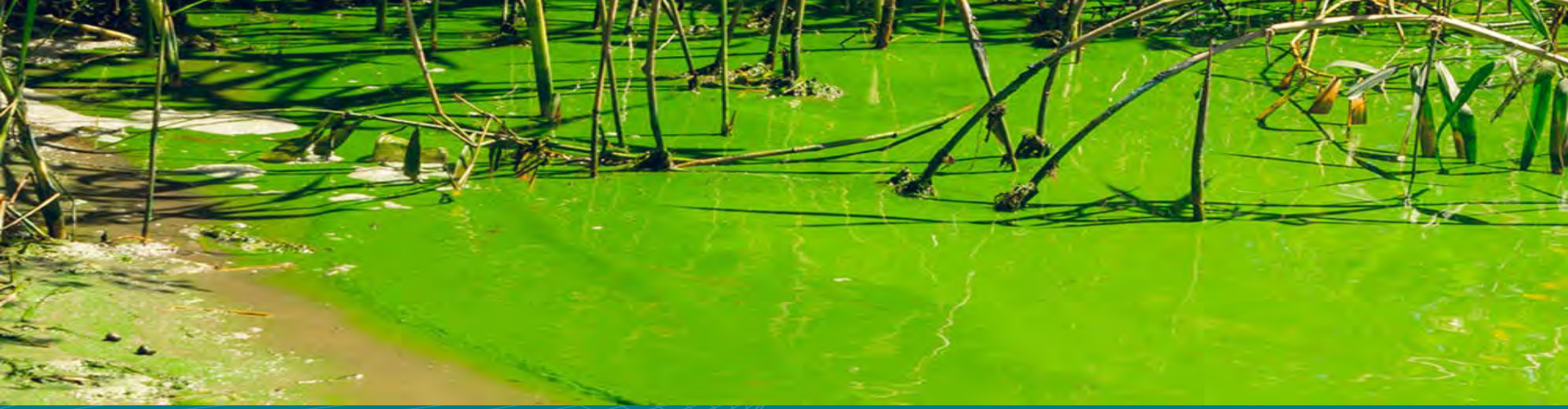


- Adsorption / Precipitation / Plant and Microbial Uptake
  - Used to removed the dissolved fraction (<0.45 µm)



National BMP Data base

http://www.bmpdatabase.org/Docs/BMP%20Database%20Nutrients%20Paper%20December%202010%20Final.pdf



Nitrogen

Hydro International®

Nitrogen (N^2)

- Multiple forms of nitrogen make its management challenging;

- Total Nitrogen (TN) =
  - Particulate Organic Nitrogen (PON)
  - Dissolved Organic Nitrogen (DON)
  - Nitrate (NO_3)
  - Nitrite (NO_2)
  - Ammonia (NH_3)
  - Ammonium (NH_4)

- The two primary concerns with nitrogen in stormwater are eutrophication and toxicity.

Nitrogen (N^2)

- Nitrate (NO_3)
  - Food preservatives, Blue Baby Syndrome
- Nitrite (NO_2)
  - Used to treat heart failure, cyanide poisoning
- Ammonia (NH_3)
  - Colorless gas with many industrial uses
  - Anhydrous Ammonia is injected directly into soil as a fertilizer
- Ammonium (NH_4)
  - Important source of nitrogen for plants, especially in hypoxic (low oxygen) soils

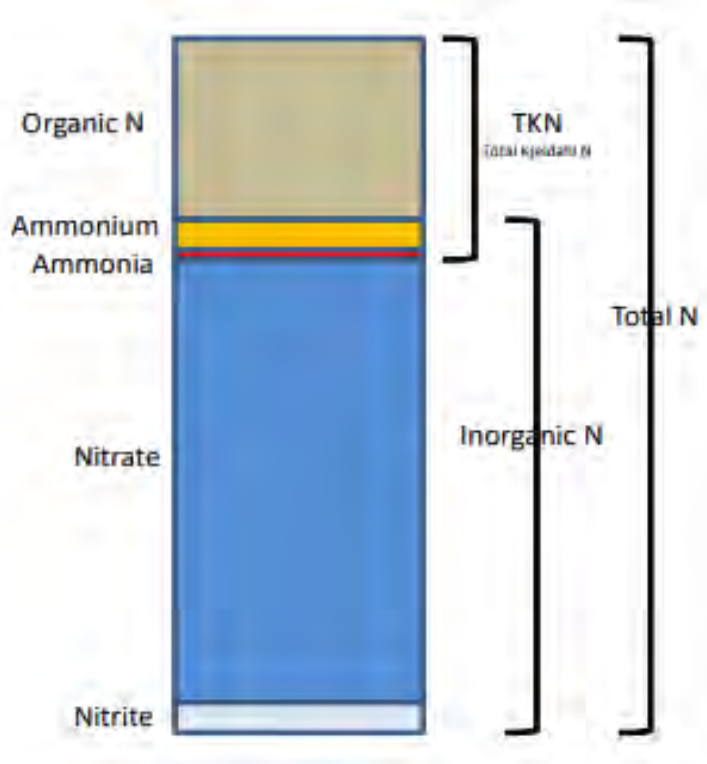
Golf of Mexico Hypoxic Zone

- Nitrogen is considered a limiting nutrient in the Gulf of Mexico

https://www.pca.state.mn.us/sites/default/files/wq-s6-26a2.pdf

TKN (Total Kjeldahl Nitrogen)

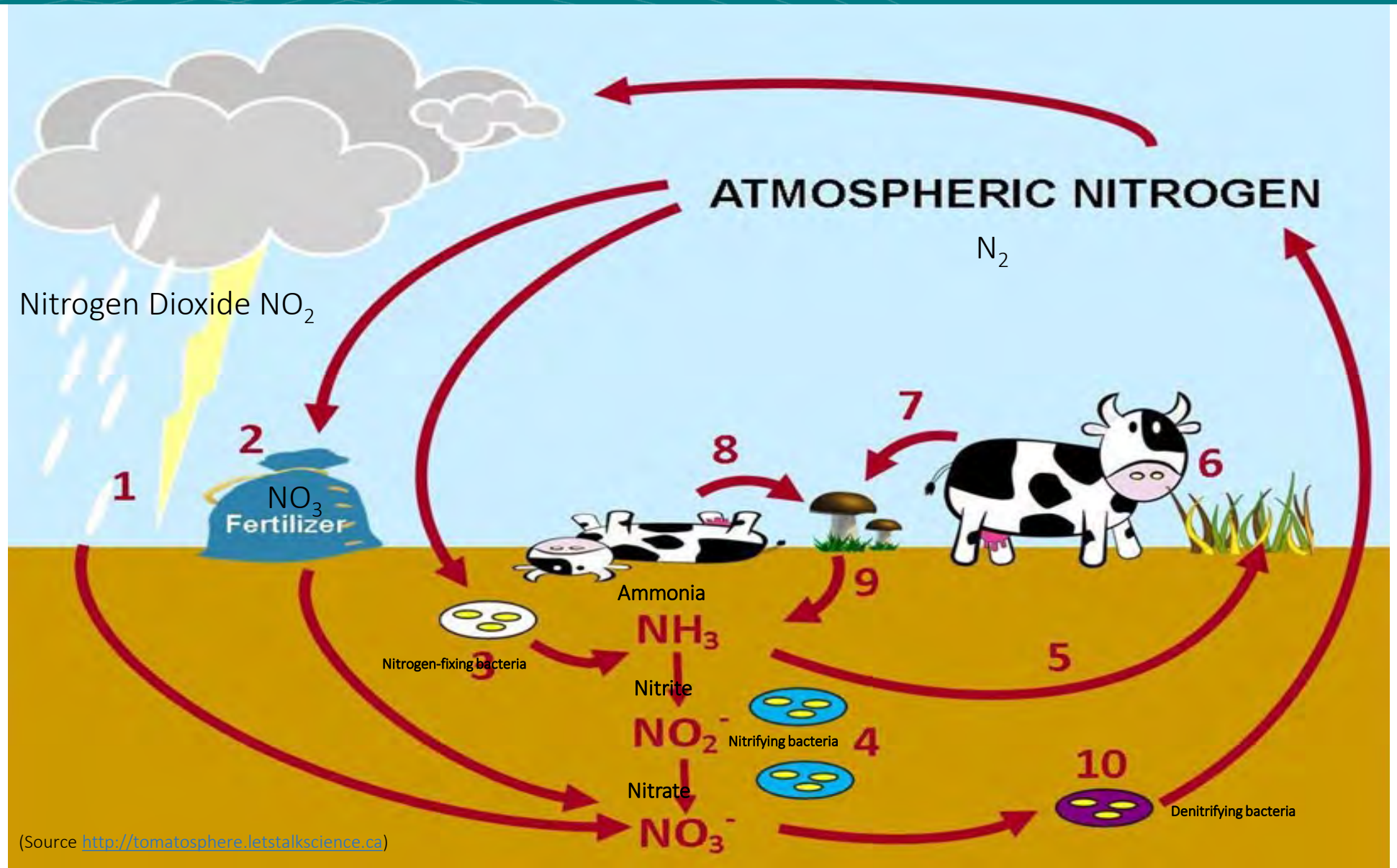
- The original TKN method was developed by the Danish chemist Johan Kjeldahl in 1883
  - The total concentration of;
    - *Organic Nitrogen*
      - Contained within living things
    - *Inorganic Nitrogen (Total Ammonia)*
      - Ammonia (NH_3 colorless gas)
      - Ammonium (NH_4 waste product from animals)



Acceptable Range 2 mg/L to 6 mg/L

https://www.pca.state.mn.us/sites/default/files/wq-s6-26a2.pdf

Nitrogen Cycle



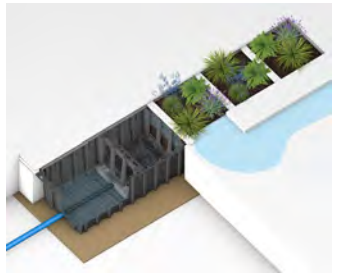
(Source http://tomatosphere.letstalkscience.ca)

Fun Fact

Certain plants also have the ability to fix nitrogen so that it can be taken up and used directly by the plants. These types of plants are called **nitrogen-fixers**. They are most typically plants from the **legume family** such peas, beans, and clover. The roots of these plants contain lumps or **nodules** (Figure 2) where nitrogen-fixing bacteria called **Rhizobium** are found and where nitrogen is stored. (Source http://tomatosphere.letstalkscience.ca)

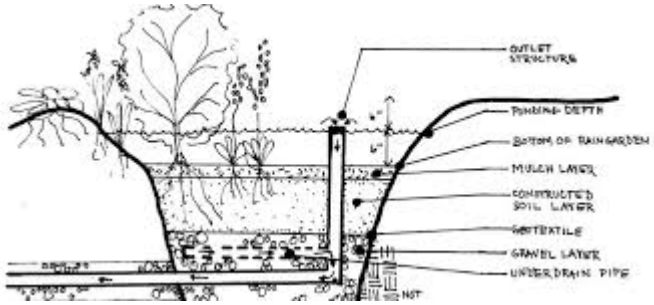
Treating Nitrogen

- Various forms of nitrogen are removed through different processes
  - BMP design must address the dominant form of nitrogen that the system is designed to treat, based on loading sources and downstream impairments
- Nitrate (NO_3)
  - Engineered bioretention designed to incorporate a continuously submerged anoxic zone with an overdrain (Kim et al., 2003)
    - *Oxygen poor environment –Bioretention-Fungi –break it down*
- Ammonia (NH_3)
  - Removed in wetlands and other long residence time treatment BMPs through volatilization and **microbially-mediated** oxidation/nitrification rocesses.
    - *Oxygen rich*



Mother nature

When Mother nature gets overwhelmed



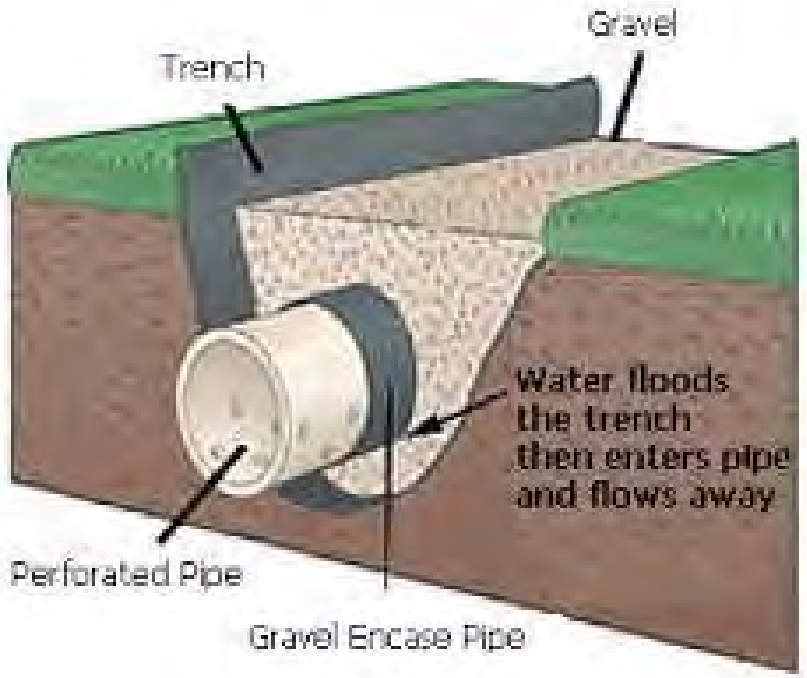
Maintenance

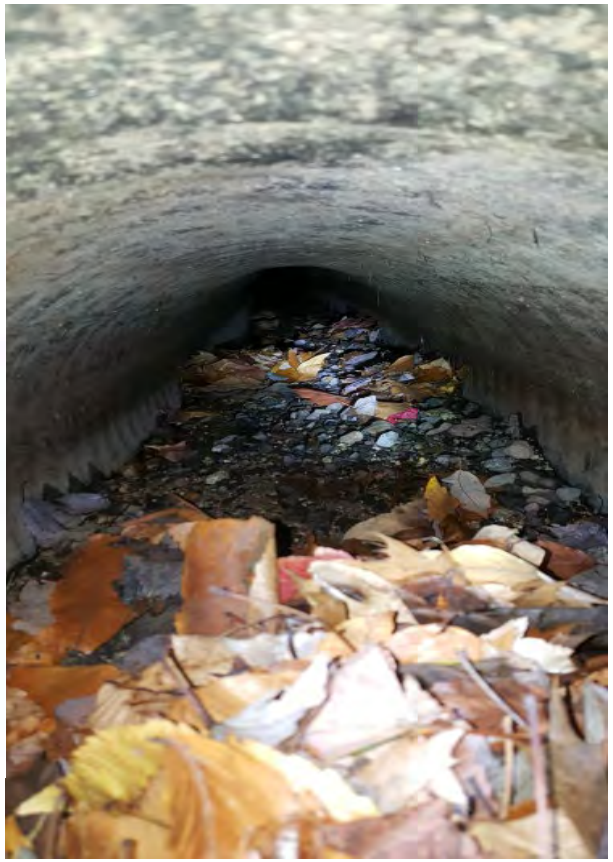
Hydro International®

Why Is BMP Maintenance Not Occurring:

1. Lack of awareness from the owner
2. Miscommunication on responsibilities & obligations
3. Lack of regulatory enforcement
4. Sites not designed with maintenance in mind

Exfiltration Trench





Bioretention

Catch Basins

Underground Detention

Ponds

Filters

- Routine maintenance is not happening
  - Most need cleaning every 12 to 16 months
  - Approximately 5% of systems are doing regular maintenance
  - Without maintenance stormwater BMPs will typically stop treating effectively after 12 to 24 months of operation

at installation

after 18 months

after 36 months

Physical Pollutants

- Sediment
  - Inorganic minerals
  - Chemically inert
- Temperature
  - Clear water = cooler
  - Turbid water = warmer
  - Heating from impervious surfaces
- Gross Solids
  - Trash
  - Debris

Chemical Pollutants

- Nutrients
  - Phosphorous / Nitrogen / Potassium
- Metals
  - Lead, Zinc, Copper,
    - *Toxic at very low levels*
- Hydrocarbons
    - *Toxic at very low levels*
- De-icing Compounds
  - Salts
    - *Toxic to fresh water plants and animals*
- Organic Compounds
  - Detergents / Solvents (voc) / Pesticides / Herbicides / Rodenticides
  - Polychlorinated Biphenyls (PCB) – banned in the US in 1979

Summary

- We need to do better
- We need to make sure all BMP’s are being maintained
- We need to protect where we live

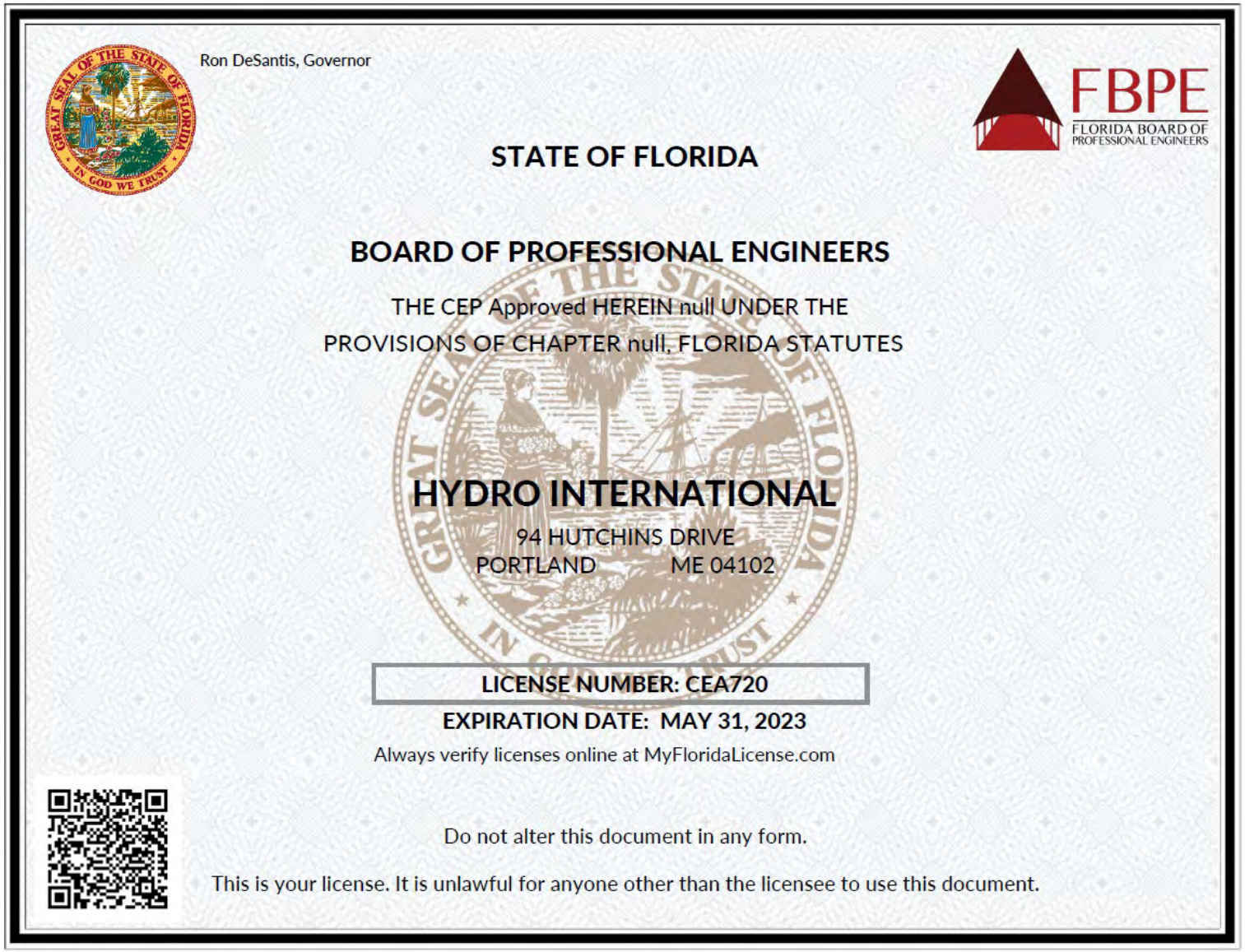
What is at Stake for the Florida Economy?

Sunshine isn't enough!

- **$2 trillion** annually are potentially at risk.
- On a smaller scale, tourism in Lee and Collier counties alone has yearly economic impact approaching **$4.5 billion**

https://www.naplesnews.com/story/news/environment/2018/07/14/floridas-algae-crisis-how-affecting-tourism-other-businesses/784599002/

Looking for your PDH / CEU just let me know



Ron DeSantis, Governor

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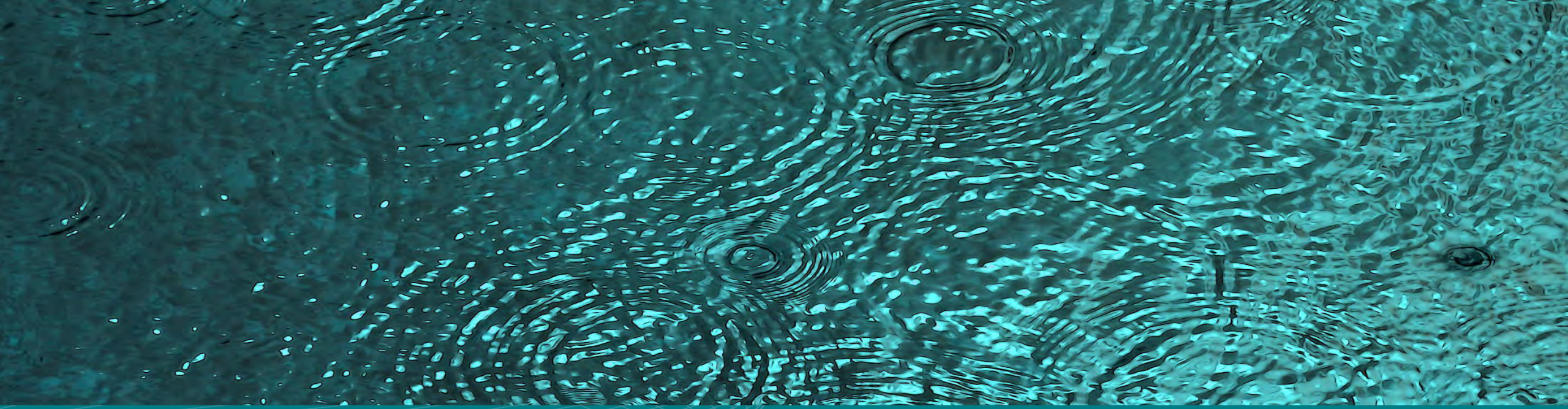

Thank you

Susan McNamee – Regional Sales Manager FL | TX | NM

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