LAKE LIMERICK AND LEPRECHAUN

OCTOBER 19, 2019

GLSM, OH, drinking water source

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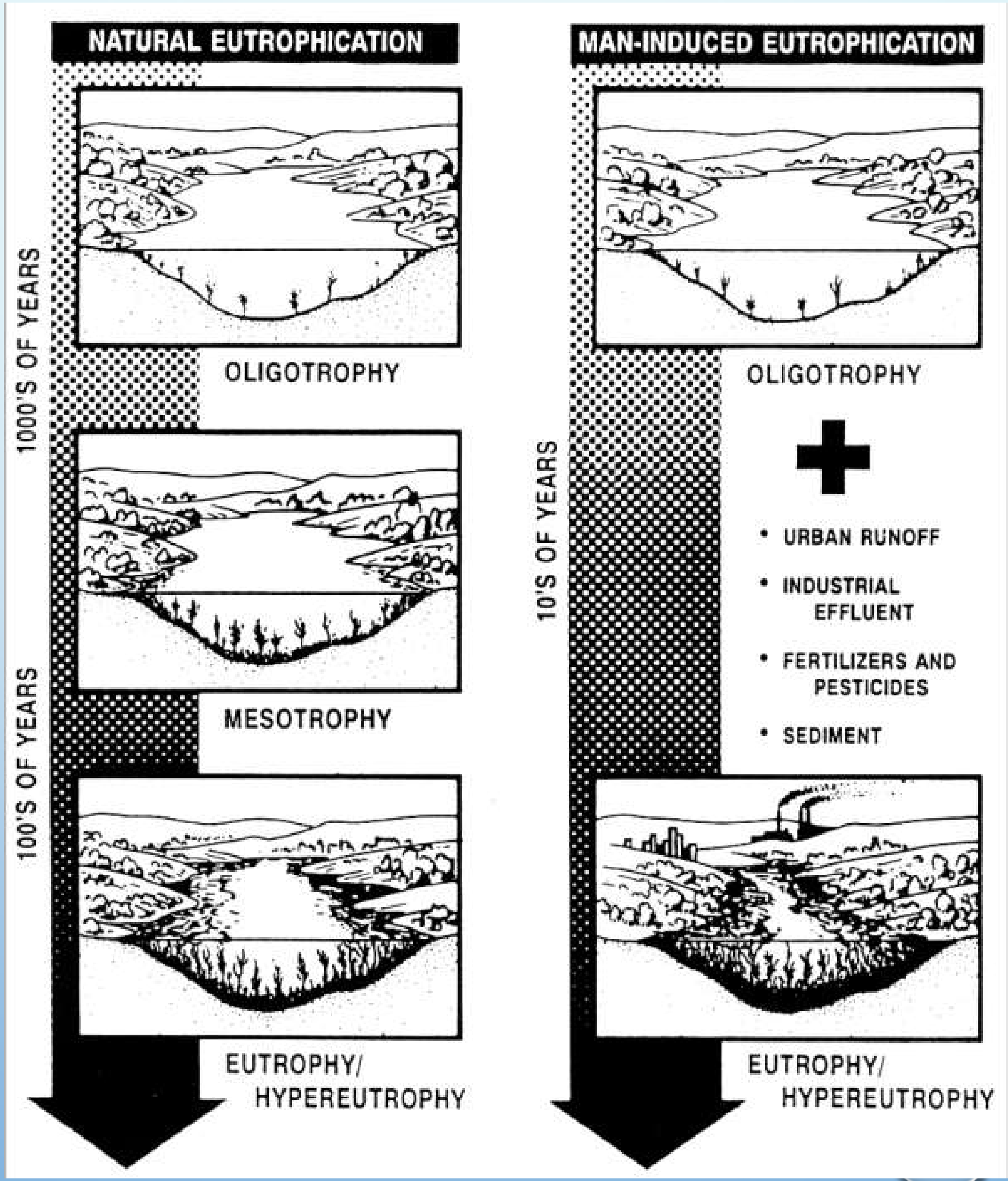
LAKE LIMERICK AND LEPRECHAUN TECHNICAL HISTORIC PERSPECTIVE

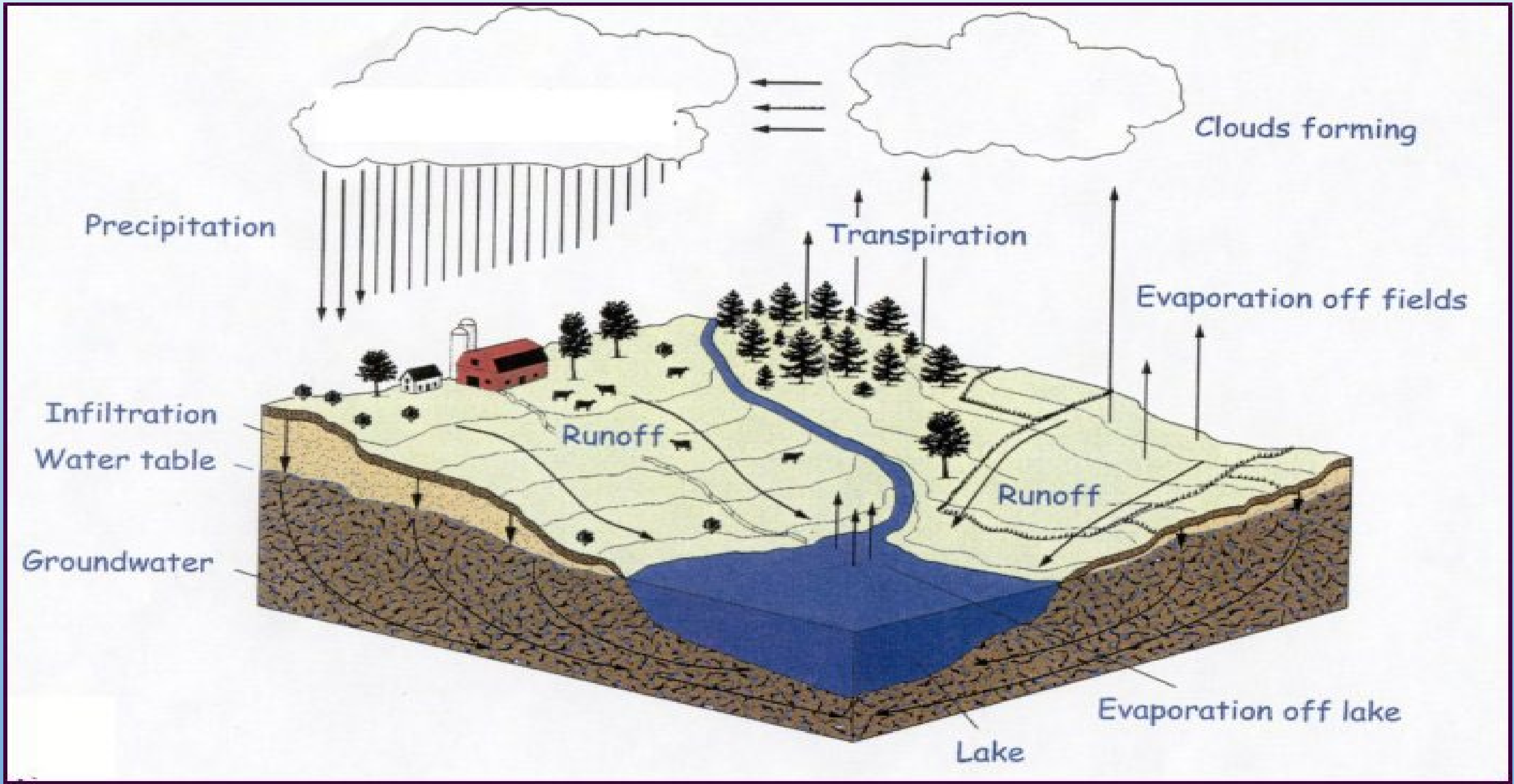
- Until recently both lakes were in their early to mid-life development, but now they are starting transition from a clear blue lakes to a wetlands and dryland – <u>however</u> this process can be <u>slowed down</u>.
  - Physical, chemical, and biological state of the lakes in terms of human years are:
    - Limerick is in its early 60’s
      - For the last 40 years it has been trying to get fat (over production of aquatic plants leading to increase in organics and decline in water quality)
    - Leprechaun is in its mid to late 70’s
      - This shallower lake started out with more organics in its sediment and less flushing than Limerick so it aged faster.

Nutrient Enrichment is controlled by Flushing, Retention, and Watershed to Storage Volume ratio. Note reservoirs have large watershed to water storage ratios, accelerating nutrient enrichment



Also climate change is enabling HABs, as well as over enrichment by human activities. This is due to increased nutrient delivery from watershed, more light, and higher temperatures.

WATER CYCLE FROM A WATERSHED PERSPECTIVE



WATER CYCLE IMPACTS

- Water retention, inflow and outflow define lake and reservoir:
  - Existence, physical morphology and sedimentation rate (capturing of nutrients and solids)
  - Rate of chemical interaction (leading to internal fertilization)
  - Availability of chemicals to drive biological growth
  - Biological residence time relative to flushing decreases with time.
  - Biochemical feed back rates increase over time.
- Key factors – Residence Time and Flushing Rate, Climate Change

WHAT DRIVES AQUATIC LIFE

- WATER
- Light is the energy source
- Nutrients (carbon, nitrogen and phosphorus) are the building blocks for cells
- Temperature
- It all starts with plants driven by light and nutrients
  - Once in motion, carbon fixation (photosynthesis) controls the rate of nutrient cycling that is driven by biological metabolism
- Within the constraints of seasonality, plant and algal growth is driven by nutrient availability, which is in turn dominated at times by the biological community

NUTRIENT LOADING

- THINGS TO KEEP IN MIND,
  - IMPERVIOUS VS PERVIOUS AREA
  - VEGETATED SURFACES RELATIVE TO STORAGE AND POLLUTION RETENTION VS NON-VEGETATION SURFACES
  - INDUSTRIAL SURFACES GENERATE UP TO 20 TIMES THAT OF FORESTED AREAS WITHOUT HARVESTING IN TERMS OF NITROGEN AND PHOSPHORUS
  - AG LANDS CAN GENERATE UP TO 40 TIMES THAT OF FORESTED OLD GROWTH AREAS IN TERMS OF NITROGEN AND PHOSPHORUS
  - SUBURBAN AND URBAN LAND-USE WILL GENERATE 10 TO 20 TIMES THE NUTRIENTS OVER BACKGROUND LEVELS.

WHAT CAN LIMIT CYANOBACTERIA AND AQUATIC PLANT PRODUCTION

Light, C, N & P

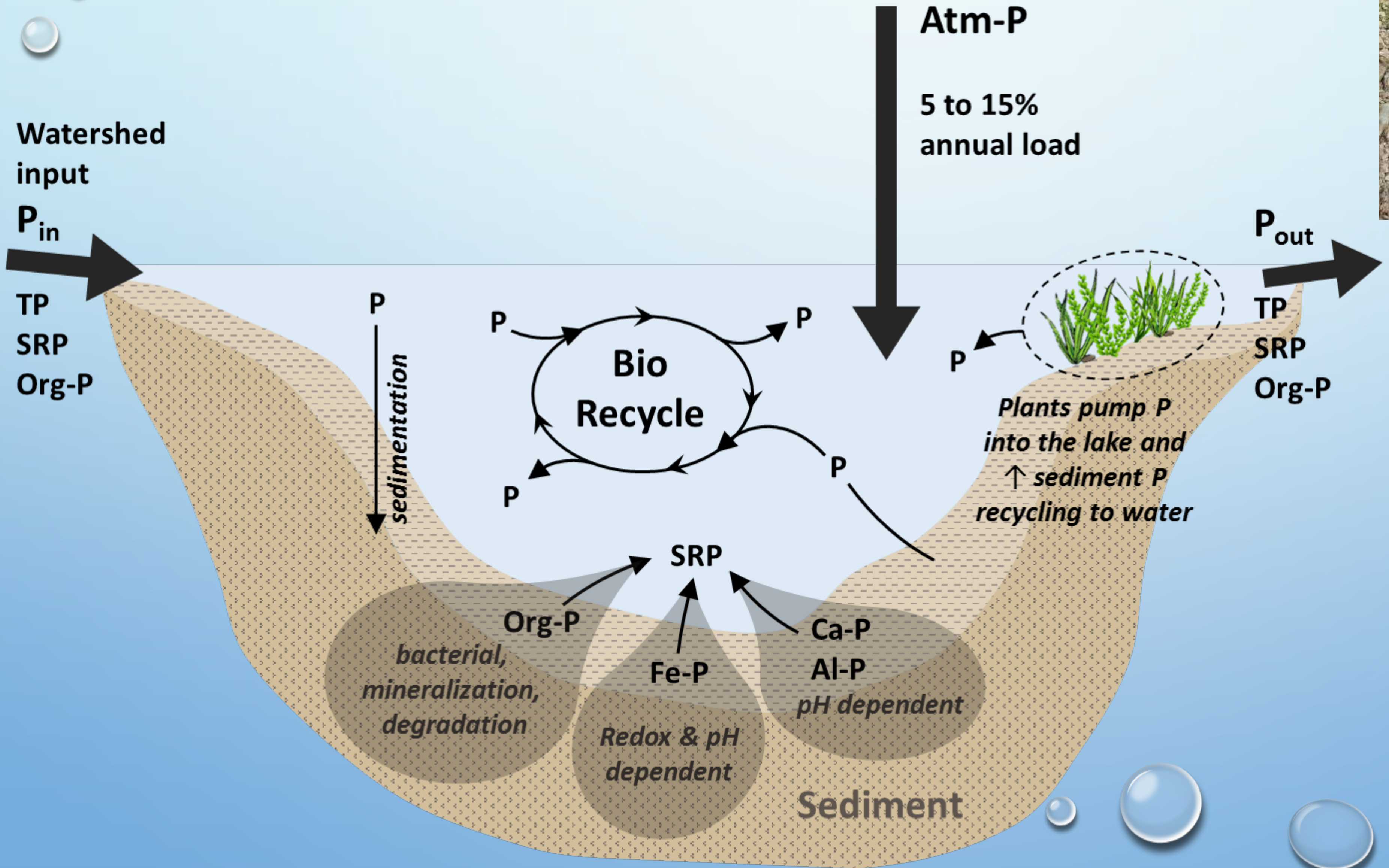
- BGs and aquatic plants are well adapted to light, not truly limiting without 72 hours of no light (riparian shade or water depth).
- Carbon dioxide is increasing in the atmosphere as in lakes and reservoirs, so it is not a limiting factor.

Loading of N and P to water bodies from external source, watershed, can be 20 to 40 times background levels.

- That will stimulate 20 to 40 times the algal biomass because of lake internal recycling!
- Even with BMPs in place at 50% nutrient retention that is 10 to 20 times background, at 90% retention it is still 2 to 4 times the background rate!

<u>That is why HABs (toxic algal blooms) and excessive plant growth occur, too much nutrients!</u>

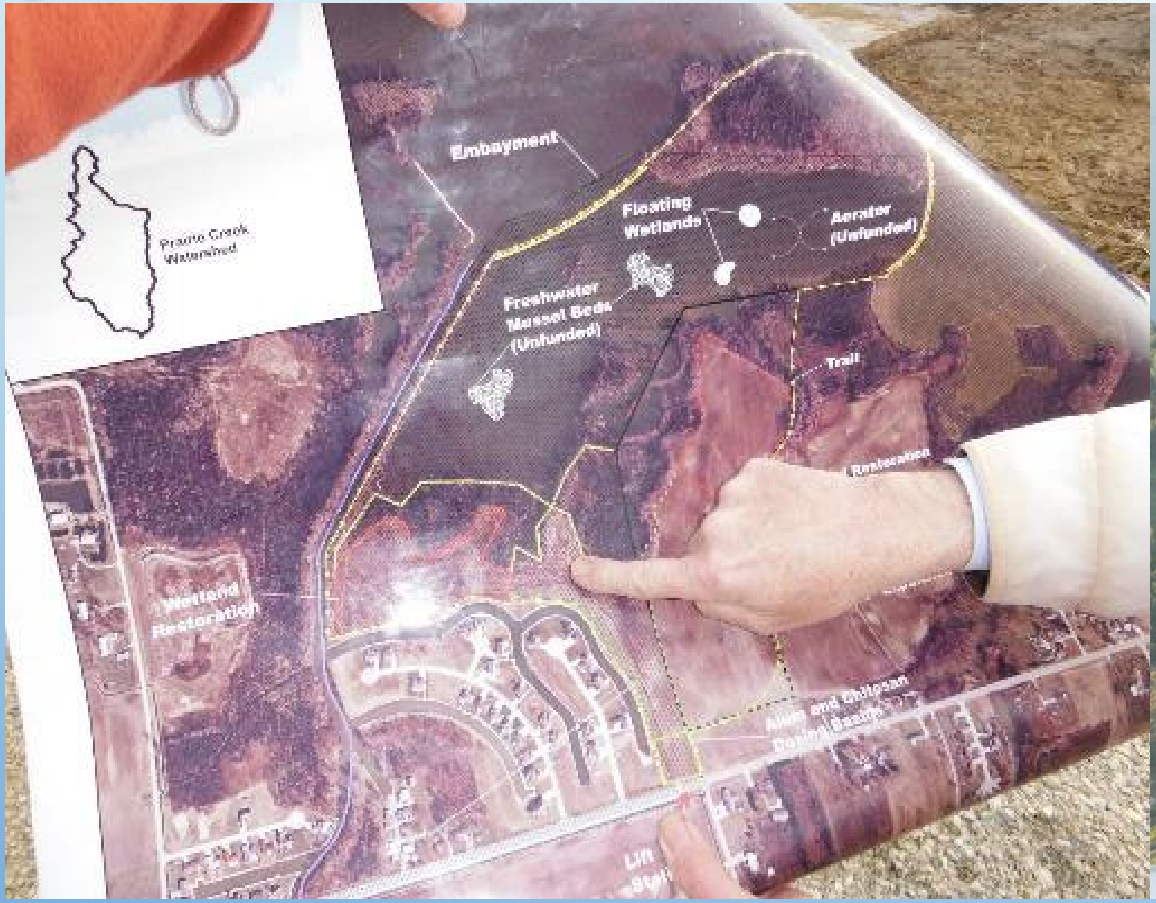
PHOSPHORUS CYCLE



WATERSHED MANAGEMENT

- Watershed management of phosphorus loading is the key to slowing accelerated eutrophication
- To prevent or slow premature hypereutrophy, phosphorus loading to lakes and reservoirs must be controlled.
- The watershed is the ultimate source of phosphorus for lakes and reservoirs
  - It is the source of sediment phosphorus,
  - It recharges sediment phosphorus, and
  - This leads to continued internal loading of phosphorus.
- Must always address watershed phosphorus control.

BMP TREATMENT TRAINS
(Multiple BMPs in Sequence)



Proposed BMP Treatment Train for Cranberry Creek

- With a sedimentation pond near the month of Cranberry Creek both sediment and phosphorus loading into Limerick can be reduced.
    - High loads of sediment that brings in N & P into the lake during high flow events can be targeted to retain sediment, N & P from impacting Limerick.
        - This can be done by a high flow diversion pond(s) to capture sediment and with an alum or other flocculate injection to enhance retention of fine sediment and nutrients.
    - This would increase the time between dredging and reduce the excessive growth of filamentous algae and aquatic plants in the inlet bay.

CRANBERRY CREEK DETENTION POND …

- With enhanced sediment and nutrient capture this pond could be 90% effective in preventing sediment, N & P for getting into the Limerick
- Benefits to the lake will be:
  - Reduced need for dredging
  - Reduced lake aging through over-enrichment by nutrients
  - Increased aquatic habitat and recreational area
  - Reduced probability of a HAB event.
- Cost: Capital cost$150K to $350K with and annual O & M cost of $8K to $25K

MANAGEMENT OF AQUATIC PLANTS

Must be integrated to ensure:

- Habitat for aquatic and other wildlife species
- Does not increase internal recycling of nitrogen and phosphorus so as not to increase the possibility of HABs
- Must address invasive species versus promotion of native plants for enhance water quality and habitat
- This is why direct aquatic plant management within Limerick and Leprechaun is on a 4 year revolving program

PLANT MANAGEMENT IN PLAY

- On-going direct herbicide treatment on a 4 year cycle
- What more can we do?
  - Individual home owners can
    - Reduce N & P use in-house and yard
    - Maintain septic
    - Install bottom barriers (burlap fabric covers) round docks
- Implement Cranberry Creek sediment and nutrient removal
- Implement upper Leprechaun sediment removal
- Implement enhanced bird sanctuary plant and sediment management.

UPPER LEPRECHAUN SEDIMENT MANAGEMENT

- To reduce excess aquatic plant growth and the potential for development of HAB events within the lake it is proposed:
  - Drawdown the lake to enable terrestrial equipment to remove lake sediment from the north half of the lake including a small area within the mid-west bay.
  - Sediment removal would be to a depth ranging from 0.5 meters to 3 meters of sediment without impacting the clay and/or glacial till seal for the lake.
  - Relative cost assuming LLCC on-site sediment disposal: $150K to $300K.
  - Benefits would be increased depth and nutrient removal that would result in:
    - Reduced plant growth, reduced rick of HAB event, and increase in aquatic habitat diversity and slowing of the lake's aging process.

BIRD SANCTUARY SEDIMENT AND PLANT MANAGEMENT

- Due to vegetative and sediment build-up the open water area has been reduced by 20 to 35% of it original area.
- To prevent the loss of open water area, resulting from excess plant growth resulting in increased sedimentation the following is proposed:
  - One mechanical and manual removal of excessive established plants along the island shoreline areas,
  - Dredging of channel area to allow continued boat movement with sediment deposited on the island.
  - Placement of burlap bottom barriers on both lake and island near shore areas to inhibit emergent plant growth (i.e., white water lilies and cattails).
- Estimated cost: $20K to $40K per year for 4 to 8 years, then $5K per year.

SUMMARY

- Internal phosphorus loading in both lakes is still and relatively small part of its annual load, but is growing more important with time than external phosphorus loading in summer that will in time result in HAB events.
- Continued aggressive aquatic plant management needs to be continued
- It is now time to start to plan for longer term sediment nutrient control that reduces internal phosphorus recycling that can enable a HABs event.
- Both lakes are healthy and in good shape, but are now at a point where to continue the beneficial uses of these lake, advanced planning to avoid problems has to occur and start implementation to reduce life-cycle costs.
- In human terms it is time to eat right, exercise and start preventative actions.

QUESTIONS

What do you want your lakes to be?