Phosphorus in Detergents – Should we reduce the use of laundry and dishwashing appliances?

At the 2015 AGM, a question was raised about the amount of phosphorus that may be entering Kahshe and Bass Lakes via septic discharge due to the increased use of detergents from washing machines and dishwashers. As phosphorus is one of the main chemicals of concern in the Lake Steward sampling and reporting, this was a timely question that warranted further evaluation.

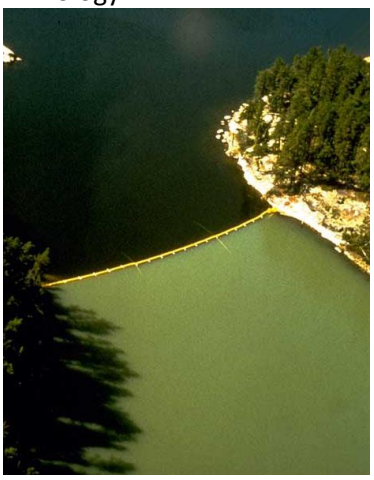
Why the focus on phosphorus?

In the 1960s and 70s, many North American rivers and lakes were experiencing rapid declines in water quality. Industrial and municipal effluents were stimulating the growth of algae and other aquatic plants (termed 'eutrophication') leading to unsightly mats of green sludge, oxygen depletion, massive die-offs of fish and other aquatic life, and problems with the taste and odour of municipal drinking water.

The public, industry, and all levels of government agreed that something had to be done. However, there was disagreement over the most effective course of regulatory action because at the time, scientists and policymakers were still debating which nutrients were responsible for eutrophication.

As experiments are the best way to establish causation, Canada's Experimental Lakes Area (ELA) was a unique location where scientists could manipulate whole lakes to test hypotheses on the scale of entire ecosystems.

In the late 1960s and early 70s, David Schindler, a Canadian limnologist oversaw a number of whole-lake experiments designed to determine which nutrient (out of carbon, nitrogen, and phosphorus) was primarily responsible for eutrophication. His studies clearly demonstrated that phosphorus was the culprit and resulted in what has been called: "the single most powerful image in the history of limnology".



ELA Lake 226: Following fertilization with carbon, nitrogen, and phosphorus (below the divider) vs. car bon and nitrogen only (above divider)

What are the major sources of phosphorus to our lakes?

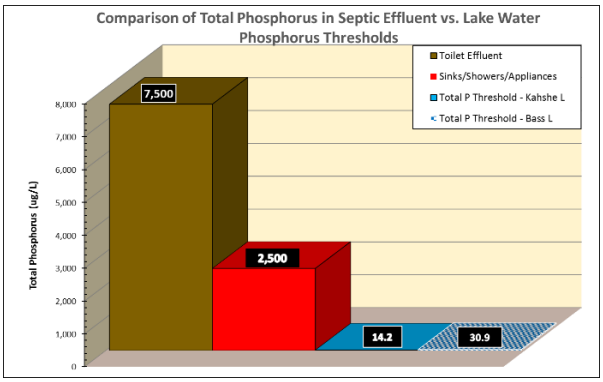
For lakes like ours, which have no immediately located industrial, municipal or agricultural operations, phosphorus enters in four main ways:

- Point sources (septic system effluents)
- Non-point sources (agricultural/lawn fertilization and land-clearing/disturbance)
- Atmospheric inputs (via rainfall and dust)
- Non-point sources within the lake (washout from shore, aquatic and semi-aquatic wildlife activity and re-suspension from rock/sediments).

Of these four potential sources, the only ones that can be controlled to any extent are highlighted above and summarized below:

- Septic system effluent
- Lawn fertilization/Land clearing/Shoreline disturbance

While there is limited data available on the breakdown of phosphorus concentrations in the various types of septic inputs, the chart below has been compiled based on the published findings from several authors.



The largest contributor to total phosphorus in septic effluent is from toilet waste, with about 75% of the phosphorus (approx. 7,500 µg/L). The remainder of the phosphorus (less than 25% of the total) comes from food waste, sinks, showers and appliances.

Phosphorus in soaps and detergents.

- Phosphates have been used in detergents for over 50 years.
- Phosphate was used to soften water, reduce spotting and rusting, keep dirt particles in suspension and to enhance surfactant performance.
- Because of this multi-functionality, phosphates are one of the most effective detergent components available today.
- The phosphate used widely in detergents was sodium tripolyphosphate, a chemical that is found naturally in many organisms.
- In wash water, sewers or natural waters, detergent phosphates break down to simple orthophosphates, just as do phosphates from human and animal wastes, food wastes and other organic materials.
- Phosphates do not have the same functions in dishwashers as in laundry cleaning. In dishwashers, phosphates improve rinse cleanliness, prevent "filming" of tableware and white incrustations on glassware, buffer pH (important for antimicrobial action and hygiene) and prevent deterioration of tableware surface and colours, in addition to counteracting hardness in water and in food waste minerals.
- In the wash water, sewage and in natural ecosystems, detergent phosphates break down rapidly, by hydrolysis, to give the simple soluble phosphate PO_4, the same as from the breakdown of human and animal urine and excrement, food wastes and other organic materials in waste waters.

Has there been any reduction in phosphorus concentrations?

- On July 1, 2010, a revised Canadian federal regulation came into force and effectively banned phosphorus in household dishwashing detergents, laundry detergents, and other cleaning products.
- The Regulation set the following phosphorus concentration limits for the manufacture or import of cleaning products:

Cleaning Product	Prior to 2010 % P by Weight	After 2010 % P by Weight
Laundry detergents	2.2%	0.5%
Dish-washing detergents (including hand dish-washing soap)	No Limit	0.5%
Household cleaners	No Limit	0.5%

- To verify the literature reports, I visited several major grocery and wholesale distributors and examined over 50 different laundry, dishwasher, pre-treat/stain removers and dishwashing soaps and found only one with a labelled total P concentration of <0.5% by weight. All others were phosphate free.

- I've also calculated that even if laundry and dishwasher detergents did contain the now allowed 0.5% by weight load of phosphorus (which they don't), the daily operation of both appliances would generate a daily loading of 2,400 (laundry) and 4,600 µg/L (dishwasher) of phosphorus in their water discharge.
- This is based on the weight of modern dispenser packets and the typical volume of water used by each machine (50 L for washer and 20 L for dishwasher.
- While these would be important contributions, when expressed as a concentration based on a typical daily water use of 1,600 L for a three bedroom dwelling, the total contribution to the daily input amounts to only 130 µg/L.
- This pales in comparison to the estimated toilet waste concentrations of 7,500 µg/L.
- The other important factor here is that typical total phosphorus concentrations entering the leaching bed are estimated to lie in the range of 5,000-10,000 µg/L, while target lake concentrations are orders of magnitude lower at 14 and 30 µg/L for Kahshe and Bass Lakes, respectively (blue columns in the above chart).
- This underscores the importance of maintaining our septic systems so they can achieve this significant reduction in phosphorus and in other chemicals that are now entering our septic systems as a result of replacing the phosphorus.
- These include non-ionic and ionic surfactants, enzymes and for laundry detergents brighteners and fragrances.

So… should we reduce the use of laundry and dishwashing appliances?

Well, the answer is that we should reduce the use of laundry and dishwasher appliances, but **not** because of the phosphorus concentration in detergents. Here's why.

1. Legislative action has effectively eliminated phosphorus from laundry and dishwasher detergents. However….
2. The increased volume of water from these appliances results in greater and more uneven flow through the septic system and can cause phosphorus to be de-sorbed from soil and migrate towards the lake.
3. The greater volume of water flow also will carry other more mobile contaminants like chloride and nitrates more quickly and in greater quantities to the lake. And…
4. Some of the chemicals that have replaced phosphorus in cleaning products have not yet been well studied and may migrate to the lake and adversely affect aquatic life.

Based on the literature I reviewed, here are a few things we can do to minimize the impact of using laundry and dishwashing appliances:

- Spread out the use of the washing/dishwashing appliances to better distribute the water flow;
- Make sure the detergent is labelled as phosphate free;
- Minimize the amount of pre-washing/rinsing of dishes and avoid flushing of food wastes;
- Avoid the use of powdered/dry detergents as they contain fillers or extenders that may clog your drain system; and,
- Regularly inspect and pump your septic tank as this removes a major amount of phosphorus that resides in solid wastes.

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