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# The role of groundwater-lake interactions on the discharge of nutrients to large lakes

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Groundwater-surface water interactions play an important role in controlling the behavior of inorganic chemicals near the sediment-water interface (SWI) and the subsequent flux of these chemicals to receiving surface waters. Previous studies have shown that dynamic groundwater flows and water exchange across the SWI can set up strong geochemical gradients and an important reaction zone near the SWI that affect the fate of reactive chemicals. Despite extensive research conducted on the fate of nutrients near the SWI in marine and river settings, there is limited knowledge of the mixing and reaction zone that exists at the interface of large inland lakes and the subsequent effect on groundwater-derived nutrient loading to nearshore waters. For example, groundwater-derived nutrient fluxes to lakes are often estimated by multiplying the groundwater flow rate by nutrient concentrations measured in landward monitoring wells. This approach ignores that nutrients can undergo important transformations in the reaction zone near the SWI.

The objective of this study is to evaluate the transport and transformation of septic-derived nutrients through a sandy nearshore aquifer and assess their ultimate discharge to the lake. Field investigations were conducted in 2014 and 2015 downgradient of a large public septic system near Lake Huron. The sampling was designed to understand the seasonal variability as well as physical and geochemical factors controlling nutrient distribution in the nearshore aquifer. The study shows a nutrient plume extending more than 70 m away from the septic tile beds with elevated phosphate and nitrate concentrations decreasing closer to the reaction zone at the SWI. The study shows the attenuation of P along its discharge pathway and extent to which P retardation may pose a legacy contamination issue. Further the study examines how dynamic flow and geochemical processes in the reaction zone impact the flux of inorganic nitrogen to the lake. Knowledge of the processes controlling the delivery of septic-derived nutrients to lake waters and the role of the reaction zone near the SWI in regulating this loading is essential to quantify nutrient loading to lakes and thus inform management actions aimed at limiting the proliferation of algae blooms and destruction of habitats and biodiversity.