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Use of the artificial sweetener acesulfame to evaluate variability in septic system effluent contributions to streams

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Summary

Septic systems are often cited as an important contributor to rural watershed nutrient loads despite limited quantitative evidence regarding their actual contributions. Recent studies have shown that measurement of the artificial sweetener acesulfame in streams may be a useful tool to quantify upstream inputs of septic system effluent. However, there is a lack of detailed study on this application, including temporal variability, influence of dry and wet weather conditions, and disentangling the contributions from functioning versus failing septic systems. Further, this approach has not been applied to assess the relative contribution of septic systems to nutrient watershed loads. Here we conducted artificial sweetener and nutrient stream measurements at the outlets of twelve watersheds in Southern Ontario, Canada with no other identified sources of acesulfame (e.g., no municipal wastewater treatment plants, landfills). The study watersheds had varying surficial geology, septic system density, watershed area, and average septic system age. Measured acesulfame stream loads were used to calculate the fraction of septic effluent generated in the watershed that reaches the watershed outlets. Overall, the fraction of septic effluent reaching the outlets varied between the watershed with no clear relationships observed with the surficial geology, watershed area, or septic system density. For all watersheds, the measured acesulfame stream loads where greater for high stream discharge compared to low stream discharge conditions suggesting more septic effluent reaches the watershed outlets under wet weather conditions. This indicates that sampling under low discharge conditions only may underestimate septic effluent delivery to streams. The acesulfame concentration-stream discharge (*C*-*Q*) relationship was positive for five of the watersheds indicating that pathways associated with less dilution of acesulfame (and septic effluent) may be important under high discharge conditions. One such pathway is overland runoff that may become activated during wet weather conditions and deliver septic effluent from failing septic systems (i.e. effluent breakout to surface from septic drain field). The concentration-stream discharge was examined more closely in five watersheds where the changes (hysteresis) in the acesulfame concentrations over individual rain events was used to disentangle the pathways delivering septic effluent to the

watersheds during wet weather conditions. These show that different pathways may dominate for different watersheds and at different times of year. Finally, for all watersheds the estimated contribution of septic systems to measured total phosphorus stream loads on a given sampling day varied widely, whereas septic system contributions to nitrate loads were typically low (<2%). The study findings provide guidance on the application of acesulfame as a tracer for quantifying septic effluent contributions of nutrients (and possibly other wastewater contaminants) to rural watershed streams.