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# Treatment of municipal wastewater in full-scale on-site sand filter reduces BOD efficiently but does not reach requirements for nitrogen and phosphorus removal

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## Abstract

© 2017, The Author(s).A traditional sand filter for treatment of household wastewater was constructed in the fall of 2012 at Biolinja 12, Turku, Finland. Construction work was led and monitored by an authorized wastewater treatment consultant. The filter was placed on a field bordered by open ditches from all sides in order to collect excess rain and snowmelt waters. The filter was constructed and insulated from the environment so that all outflowing water was accounted for. Untreated, mainly municipal, wastewater from Varissuo suburb was pumped from a sewer separately via three septic tanks (volume = 1 m3 each) into the filters. Normally, wastewater was distributed to ground filters automatically according to pre-programmed schedule. Initially, the daily flow was 1200 L day−1 to reflect the average organic load of a household of five persons (load: ca 237 g day−1 BOD; 73 g day−1 total N; and 10.4 g day−1 total P). Later in the test, the flow rate was decreased first to 900 and then to 600 L day−1 to better reflect the average volume produced by five persons. Volumes of inlet wastewater as well as treated water were monitored by magnetic flow meters. Samples were withdrawn from the inlet water, from the water entering the filters after the third septic tank, and from the outflowing water. After an initial adaption time, the reductions in BOD and chemical oxygen demand were constantly between 92 and 98%, showing that the biological degradation process in the filters functioned optimally and clearly comply with the national and EU standards. The reduction in total nitrogen and total phosphorus, however, reached required levels only during the first months of testing, apparently when buildup of microbial biomass was still ongoing. After this initial period of 3 months showing satisfactory reduction levels, the reduction of total nitrogen varied between 5 and 25% and total phosphorus mostly between 50 and 65%. Nitrification was efficient in the filter, but as indicated by high nitrate levels and poor nitrogen reductions, denitrification was inefficient or absent. During the winter period, the temperature in the filter dropped to near freezing, but at all time points, the flow of water was unaffected by freezing. During snowmelt and heavy rain, occasional flooding was observed. Such situations may lead to dilution rather than purification of the wastewater. In conclusion, the sand filter tested worked well for reduction of the organic load in municipal wastewater but failed to sufficiently reduce nitrogen and phosphorus levels.

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## Keywords

BOD, Household wastewater, Nitrogen removal, Phosphorus removal, Sand filter

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