# Evaluation of the efficiency of on-site sewage facilities in the removal of micropollutants and assessment of the impact of their effluents in the receiving aquatic ecosystem

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**Abstract**
In sparsely populated areas, the use of cost-effective small-scale on-site facilities (OSSFs) is widespread. One of the main risks associated with effluents from OSSFs is considered to be the release of micropollutants in receiving water bodies. However, data on this regard is still scarce. In this study, the presence of a large number of micropollutants was evaluated in the influents and effluents of different types of OSSFs. The concentration levels and the removal efficiencies were compared between these small-scale facilities and medium and large scale conventional wastewater treatment plants (WWTPs). Finally, the impact of these facilities in the receiving aquatic ecosystem was evaluated.

**Keywords**
on-site sewage treatment facility, micropollutants, wastewater, LC-HRMS, removal efficiency

## INTRODUCTION

The establishment of conventional wastewater treatment plants (WWTPs) for the sanitation of wastewater is not feasible in sparsely populated areas. This is an important issue in Sweden, where approximately 700 000 private households are currently not connected to public WWTPs. In these cases, the use of more cost-effective small-scale on-site facilities (OSSFs) is widespread. These facilities mainly consist of a sludge separation in a septic tank with subsequent on-site treatment and then draining of the treated effluent to groundwater or surface water. One of the main risks associated with effluents from OSSFs is considered to be the release of micropollutants in receiving water bodies. Several studies focused on the removal of micropollutants in conventional WWTPs, showing very different efficiencies depending on the specific compound [1]. There is the suspicion that OSSFs are less efficient although the number of studies in this regard is scarce [2]. The present study aims to compare the removal efficiencies for a wide range of micropollutants between OSSFs and large and medium scale WWTPs. The impact of these facilities in the receiving aquatic environment will be evaluated by analysing the detected compounds in areas where water is assumed to be heavily affected by these facilities.

## MATERIAL AND METHODS

Influent and effluent wastewater samples were collected from different OSSFs and also medium and large scale conventional WWTPs located in the vicinity of the cities of Uppsala, Stockholm and Umeå (Sweden). In order to assess the impact of OSSFs sewage water discharges on water quality, surface water samples were collected from seven locations in the vicinity of Uppsala (population size: 200 000 inhabitants). The selected sites are influenced by different OSSFs but also by small and large-scale WWTPs as described in Figure 1. Samples were extracted by solid phase extraction (SPE) and further analysed by UHPLC-HRMS using a UHPLC system coupled to a G2S Xevo quadrupole-time-of-flight (QTOF) mass spectrometer.

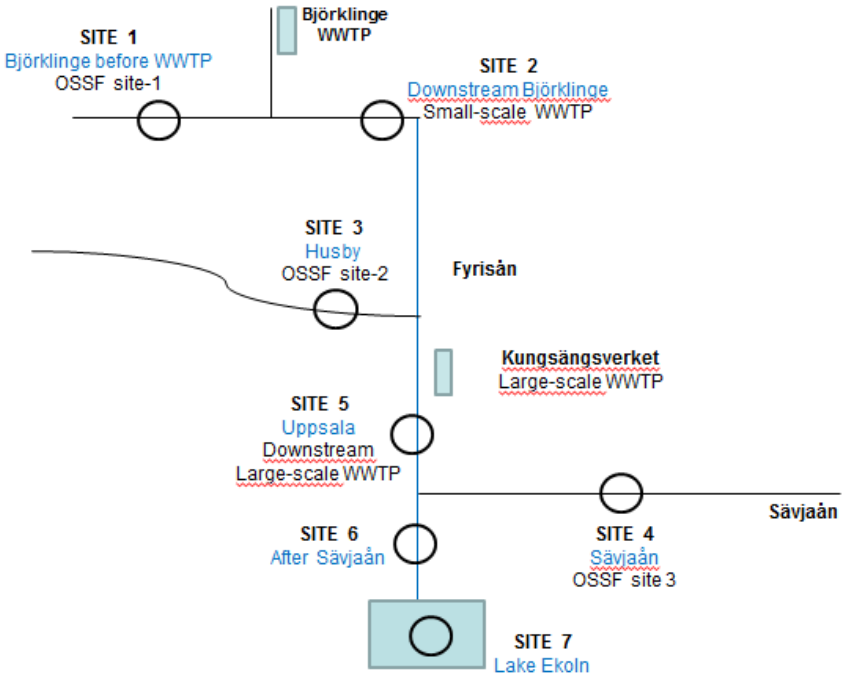


**Figure 1**. Sampling design.

## RESULTS AND DISCUSSION

The presence of 79 micropollutants including pharmaceuticals, personal care products, pesticides, artificial sweeteners, perfluoroalkyl substances (PFASs) and related transformation products were evaluated in the wastewater and in the surface water samples. Up to 60 substances were detected in the wastewater samples. In the OSSFs of smaller size (serving a population of up to 30 inhabitants), the number of detected compounds was significantly lower (<20 compounds) than in larger ones. However, no significant differences were observed in terms of the number of detected compounds between larger OSSFs and the medium and large scale WWTPs (overall range 40-55 compounds). The determined concentrations do not allow generalization, since large variations were observed depending on the given compound. The studied facilities showed a varying pattern of removal efficiencies. Some substances showed high removal efficiency (e.g. parabens), while other substances showed no significant removal (e.g. diclofenac). Overall, the OSSFs showed similar efficient performance than medium or large scale conventional WWTPs. The concentrations found in the surface water samples described in Figure 1 show how water quality is directly related to the presence of OSSFs and WWTPs. In all cases, both the number of compounds as the concentration of these increased significantly after the input of a sanitation facility, although the highest concentrations were found at the sampling location after the large WWTP of Uppsala. Overall, our results show that OSSFs significantly affect water quality with respect to the presence of micropollutants.

## REFERENCES

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