Tracking PFASs in Swiss Wastewater Treatment Plants

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Per- and polyfluoroalkyl substances (PFASs) are globally distributed and highly persistent environmental contaminants. Already, PFASs have been widely detected in groundwater and surface waters throughout Switzerland [1]. Elevated PFAS levels in point sources may cause receiving water bodies to exceed proposed European environmental quality standards [2]. To inform effective pollution prevention policies, it is crucial to understand the loads and profiles of PFASs in use. Wastewater treatment plants (WWTPs) can serve as integrative sampling points to profile PFAS levels from diverse domestic and industrial sources within different catchments. From 2023-2024, we sampled sludge and weeklong composite wastewater from 21 WWTPs in Switzerland, serving 25% of the population. Using online solid-phase extraction liquid chromatography high-resolution mass spectrometry (HRMS), we measured over 65 target PFASs and collected data-dependent spectra for follow-up suspect screening.

Sludge and wastewater were complementary compartments for estimating PFAS mass flows, with sludge accounting for 1-40% of the total flows in individual WWTPs. Ultrashort-chain PFASs containing 1-3 CF_2 groups were exclusively detected in wastewater while long-chain PFASs containing 9-16 CF_2 groups were only found in sludge. Most WWTPs contained a group of ubiquitously present PFASs; however, several WWTPs had more unique profiles with less commonly occurring PFASs, potentially indicative of intensive upstream PFAS usage or discharge. Strikingly, the emerging zwitterion 6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB or Capstone B) was detected in nearly every sample of wastewater and sludge. Median measured concentrations in wastewater (85 ng/L) and sludge (48 ng/g) were respectively 8-fold and 3-fold higher than the next most abundant PFAS. Despite its phase-out in 2011 and complete usage ban in April 2024, perfluorooctane sulfonic acid (PFOS) remained the second most abundant PFAS measured in sludge (median 15 ng/g) and fourth in wastewater (8.5 ng/L). The total oxidizable precursor (TOP) assay revealed up to 69-fold (median 5-fold) more undetected PFAS precursors were present in wastewater compared to targeted PFASs, suggesting targeted monitoring may greatly underestimate wastewater discharge of PFASs. These results provide an overview of relevant and potentially emerging PFASs currently used in Switzerland as well as practical insights for future monitoring studies.

[1] BAFU. PFAS im Grundwasser [Internet]. [cited 2025 Jan 27]. Available from: https://www.bafu.admin.ch/bafu/de/home/themen/thema-wasser/wasser--fachinformationen/zustand-der-gewaesser/zustand-des-grundwassers/grundwasser-qualitaet/pfas-im-grundwasser.html

[2] Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy [Internet]. OJ L Aug 12, 2013. Available from: http://data.europa.eu/eli/dir/2013/39/oj/eng