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Sources and pathways of biocides and their transformation products in 2ha urban district

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Biocides used as film protection products to prevent algae and fungi growth on facades wash off during rain events and represent a potential risk to the environment. So far, urban monitoring studies focused mainly on large heterogeneous urban areas. Thus, little information about individual sources and entry pathways were obtained. However, this is important to understand the potential risk of biocide entry to groundwater.

This study investigates biocide emissions from a 2 ha residential area, 13 years after construction has ended. Investigated substances represent commonly used biocides for film protection, i.e. Terbutryn, Diuron and Octylisothiazolinone (OIT) and some of their known transformation products (TPs, Diuron-Desmethyl, Terbumeton, 2-Hydroxy-Terbutylazin and Terbutryn-Desethyl). We used existing urban infrastructure for efficient monitoring and applied a three-step approach to (a) determine the overall relevance of biocides, (b) identify source areas and long-term emission and (c) characterize entry pathways into surface- and groundwater.

Initial sampling in the swale system gave an integrated signal from the entire district and confirmed the relevance of biocide leaching, more than a decade after construction. Concentrations peaked at 174 ng/L for Diuron and 40 ng/L for Terbutryn during a high magnitude event and were above PNEC values. During later events, transformation products were detected, though at lower concentrations. For all substances, source areas were identified in a second step. Artificial elution experiments confirmed expected sources, i.e. façades, but we also found additional sources through sampling of rainfall downpipes from flat roofs. A small part of the roof façade was repainted two years before sampling and thereby showed a magnitude higher leaching rates than the remaining façades. Since all biocide wash-off arrived on a flat roof and was drained by rainfall down pipes, we could estimate net biocide emission and arrived at 155 mg Diuron, 17 mg Terbutryn, 12 mg OIT and 17 mg Diuron-Desmethyl from a 10 m^2 painted façade area over a time period of two years. In a third step, we characterized entry pathways comparing samples from a drainage pipe that collected road runoff (surface pathway) with two others that collected infiltrated water on top of an underground garage (soil pathway). All drainage pipes showed Terbutryn, two of them also Diuron but none OIT. The drainage pipe representing the surface pathway showed a smaller number of individual transformation products but similar

concentrations of parent compounds. One pipe representing the soil pathway had highest concentrations of Terbutryn and its TPs which suggests a high leaching potential of this biocide also away from concentrated infiltration in urban stormwater management infrastructure.