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Benchmarking Organic Micropollutants in Wastewater, Recycled Water and Drinking Water with In Vitro Bioassays

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ABSTRACT

Thousands of organic micropollutants and their transformation products occur in water. Although often present at low concentrations, individual compounds contribute to mixture effects. Cell-based bioassays that target health-relevant biological endpoints may therefore complement chemical analysis for water quality assessment. The objective of this study was to evaluate cell-based bioassays for their suitability to benchmark water quality and to assess efficacy of water treatment processes. The selected bioassays cover relevant steps in the toxicity pathways including induction of xenobiotic metabolism, specific and reactive

modes of toxic action, activation of adaptive stress response pathways and system responses. Twenty laboratories applied 103 unique in vitro bioassays to a common set of 10 water samples collected in Australia, including wastewater treatment plant effluent, two types of recycled water (reverse osmosis and ozonation/ activated carbon filtration),stormwater, surface water, and drinking water. Sixty-five bioassays (63%) showed positive results in at least one sample, typically in wastewater treatment plant effluent, and only five (5%) were positive in the control (ultrapure water). Each water type had a characteristic bioanalytical profile with particular groups of toxicity pathways either consistently responsive or not responsive across test systems. The most responsive health-relevant endpoints were related toxenobiotic metabolism (pregnane X and aryl hydrocarbon receptors), hormone-mediated modes of action (mainly related to the estrogen, glucocorticoid, and antiandrogen activities), reactive modes of action (genotoxicity) and adaptive stress response pathway (oxidative stress response).This study has demonstrated that selected cell-based bioassays are suitable to benchmark water quality and it is recommended to use a purpose-tailored panel of bioassays for routine monitoring.