Emerging and Conventional Contaminants Discharging into the Dnieper River, Kyiv, Ukraine

Robert M Burgess, Michaela A Cashman, Kay T Ho (U.S. EPA, ORD/NHEERL, Atlantic Ecology Division, Narragansett, RI, USA); Igor Konovets, Artem Lyashenko, Sergey Afanasiev, Kateryna Zorina-Sakharova (Institute of Hydrobiology, National Academy of Sciences, Kyiv, Ukraine); Mikhail V Milyukin , Ganna V Terletska (A.V. Dumansky Institute of Colloid Chemistry and Water Chemistry, National Academy of Sciences, Kyiv, Ukraine); and Anatoly V Lyakchovsky, A.V.Bogatsky Physico-Chemical Institute, Odesa, Ukraine

Abstract:

The Dnieper River runs through the center of Ukraine from Belarus and Russia in the north and heads south emptying into the Black Sea. Along the way, the Dnieper River passes by several large Ukrainian cities including Chornobyl, the capital Kyiv, Dnipropetrovsk, and Kherson, and serves as a major drinking water reservoir. These cities are recognized as sources of conventional and emerging contamination (CCs and ECs, respectively) to the Dnieper River; however, little is known about the actual contaminant concentrations in the municipal effluent and riverine waters. The objective of the current study was to quantify the concentrations of CCs and ECs discharging into the Dnieper River from Kyiv's largest municipal wastewater treatment plant (MWTP). The concentrations of CCs and ECs in Fall 2011 and Spring 2012 were measured at up to seven stations. Samples included the MWTP influent, effluent, drainage channel stations emptying into the Dnieper River, and stations downstream and upstream of the channel. Conventional contaminants included industrial chemicals and pesticides (e.g., DDTs, α-, β-, γ-hexachlorocyclohexane) while ECs included several categories (e.g., stimulants, antibiotics). Industrial chemicals including PCBs, PAHs, DDTs, and other pesticides demonstrated concentrations ranging from 2.77 to 53.3 µg/L, 11.6 to 400 µg/L, 0.9 to 15.9 µg/L, and not detected to 22.5 µg/L, respectively, with higher concentrations often occurring in Spring 2012. Industrial chemical removal from the MWTP influent varied with chemical and season but was frequently limited providing evidence of other contamination sources contributing to the river. In contrast, total metal concentrations (2.51 to 148 µg/L) were higher in the influent in Fall 2011 and showed substantial concentration reductions in the effluent (e.g., 53 to 64% lower). The ECs, dominated by stimulants, had elevated concentrations in both seasonal influents (5.48 µg/L to 29.4 µg/L) but concentrations decreased by 96% in the post-MWTP effluent. In addition, there was no evidence of additional sources of ECs to the Dnieper River. Results suggest the MWTP serves as a source of several CCs to the Dnieper River but there are additional sources. In contrast, the ECs appear in the MWTP influent but are effectively removed prior to discharge into the effluent stream.