

## Pharmaceuticals in the Environment: Overview of Sources, Concerns, and Solutions

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Pharmaceuticals comprise a large, diverse array of contaminants that can enter the environment from the combined activities, actions, and behaviors of multitudes of individuals as well as from veterinary and agricultural use (<http://epa.gov/nerlesd1/chemistry/pharma/images/drawing.pdf>). Excretion, bathing, and disposal of leftover medications are the three primary routes of release from human activities. As trace environmental contaminants in waters, sediments, and sewage sludge, they are largely unregulated in the U.S. The concentrations of individual active ingredients in environmental samples such as surface waters often range from parts-per-billion to parts-per-trillion — micrograms to nanograms per liter. Multiple active ingredients, however, frequently occur together. The total, combined levels of these substances in a given environmental sample can be 1-2 orders of magnitude higher than their individual levels in waters, or up to the mg/kg level in treated sewage sludge ("biosolids," which is often disposed via application to land). While pharmaceuticals are ubiquitous trace contaminants in the environment, the types, concentrations, and relative abundances of individual residues will vary depending on the waste treatment technologies employed and the geographic locale and time of year; contributing variables are variations in geographic prescribing and consumption practices. The efficiencies by which pharmaceuticals can be removed from waste and water spans the entire spectrum (from nil to complete) as a function of the technology and the physicochemical properties of each active pharmaceutical ingredient (API).

Concerted research that began in Europe about two decades ago was followed by studies in the U.S. beginning in the late 1990s. The pace of this work has greatly escalated in the last few years. Investigation originally limited to studying the sources, origins, and occurrence of pharmaceuticals (primarily in waters) has now expanded to encompass occurrence in other matrices (such as sediments, sewage sludge, and biota), waste treatment options, and the complexities involved with the range of unanticipated and subtle effects that might occur for non-target organisms from low-dose, chronic, simultaneous exposure to multiple active ingredients. Risk management options designed around the principles of pollution prevention and environmental stewardship are also under consideration in the healthcare community, the states, and the pharmaceutical industry; many of the options as well as the obstacles are discussed in a 2-part monograph (available here: <http://epa.gov/nerlesd1/chemistry/pharma/faq.htm#disposal>). This presentation briefly summarizes some of what is known and not known about the occurrence of drugs in the environment, the potential for chronic effects on wildlife (and some instances of acute effects), the relevance of drug residues in drinking water to consumer risk perception, and actions that can be taken to reduce environmental exposure. Efforts are underway at U.S. federal agencies such as the USGS, FDA, USDA, NOAA, NIEHS, and the CDC, as well as the EPA. This work is beginning to be coordinated under an Interagency Task Force (PiE: Pharmaceuticals in the Environment), which was chartered under a subcommittee of OSTP's (National Science and Technology Council) Committee on Environment and Natural Resources (<http://www.ostp.gov/NSTC/html/committee/cenr.html>).

**NOTICE:** Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy

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