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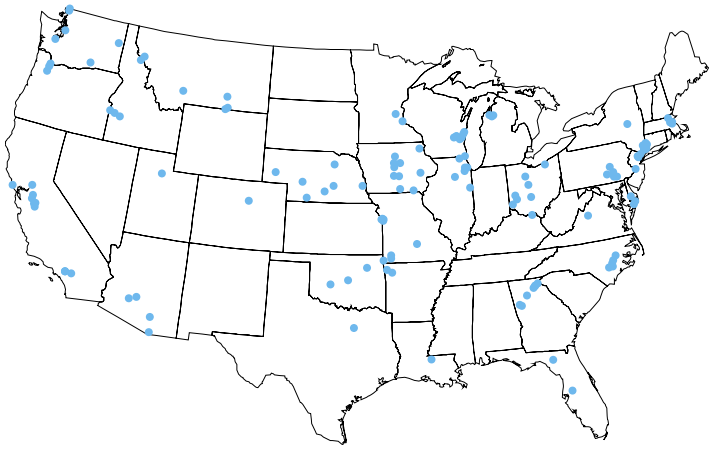
Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams

A recent study by the Toxic Substances Hydrology Program of the U.S. Geological Survey (USGS) shows that a broad range of chemicals found in residential, industrial, and agricultural wastewaters commonly occurs in mixtures at low concentrations downstream from areas of intense urbanization and animal production. The chemicals include human and veterinary drugs (including antibiotics), natural and synthetic hormones, detergent metabolites, plasticizers, insecticides, and fire retardants. One or more of these chemicals were found in 80 percent of the streams sampled. Half of the streams contained 7 or more of these chemicals, and about one-third of the streams contained 10 or more of these chemicals. This study is the first national-scale examination of these organic wastewater contaminants in streams and supports the USGS mission to assess the quantity and quality of the Nation's water resources. A more complete analysis of these and other emerging water-quality issues is ongoing.

Background: Chemicals, used everyday in homes, industry and agriculture, can enter the environment in wastewater. These chemicals include human and veterinary drugs (including antibiotics), hormones, detergents, disinfectants, plasticizers, fire retardants, insecticides, and antioxidants. To assess whether these chemicals are entering our Nation's streams, the Toxic Substances Hydrology Program of the U.S. Geological Survey (USGS) collected and analyzed water samples from 139 streams in 30 states during 1999 and 2000. Streams were sampled that were considered susceptible to contamination from various wastewater sources, such as those downstream from intense urbanization or livestock production. Thus, the results of this study are not considered representative of all streams.

Household chemicals can enter streams through wastewater discharges. A wastewater treatment facility near Atlanta, Georgia, is shown above. (Photograph by Daniel J. Hippe, U.S. Geological Survey)



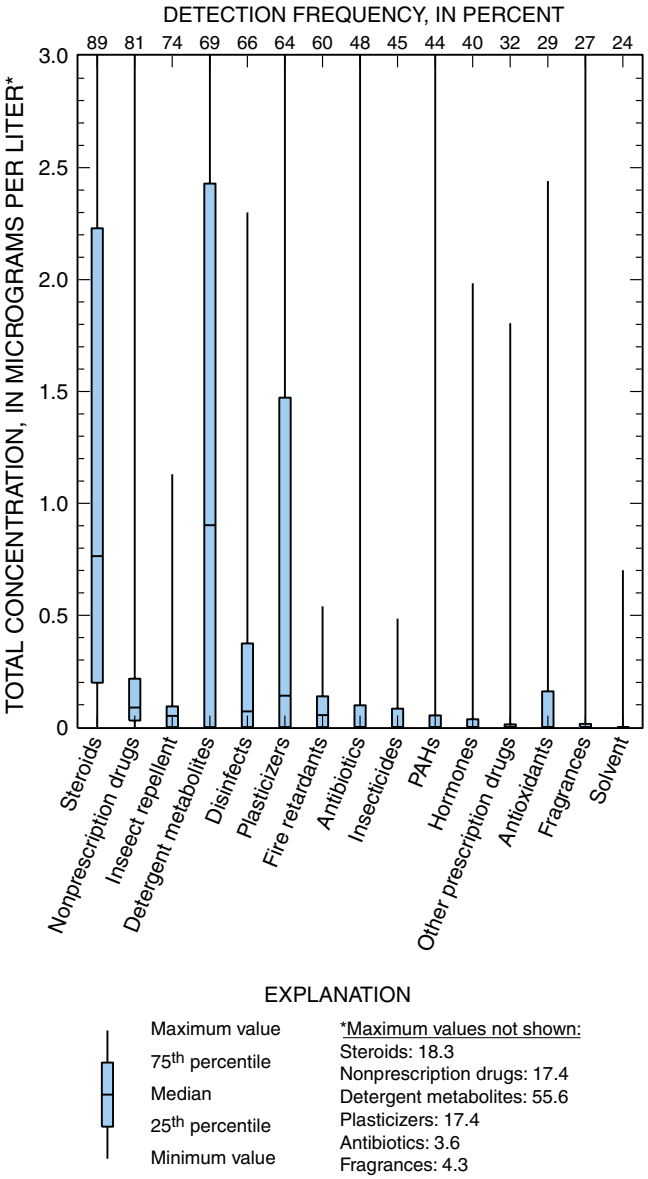
Pharmaceuticals, hormones, and other organic wastewater contaminants were measured in 139 streams during 1999 and 2000.

Although each of the 95 chemicals is used extensively, there is little information about the extent or occurrence of many of these compounds in the environment. Some may be indicators of certain classes of contamination sources, such as livestock or human waste, and some have human or environmental health implications. The results of this study are a starting point for investigation of the transport of a wide range of organic wastewater contaminants in the Nation's waters.

New laboratory methods were developed in several USGS research laboratories to provide the analytical capability to measure concentrations of 95 wastewater-related organic chemicals in water. Uniform sample-collection protocols and field and laboratory quality-assurance programs were followed to ensure that results are comparable and representative of actual stream conditions.

Findings: One or more chemicals were detected in 80 percent of the streams sampled, and 82 of the 95 chemicals were detected at least once. Generally, these chemicals were found at very low concentrations (in most cases, less than 1 part per billion). Mixtures of the chemicals were common; 75 percent of the streams had more than one, 50 percent had 7 or more, and 34 percent had 10 or more.

The most frequently detected chemicals (found in more than half of the streams) were coprostanol (fecal steroid), cholesterol (plant and animal steroid), N-N-diethyltoluamide (insect repellent), caffeine (stimulant), triclosan (antimicrobial disinfectant), tri (2-chloroethyl) phosphate (fire retardant), and 4-nonylphenol (nonionic detergent metabolite). Steroids, nonprescription drugs, and insect repellent were the chemical groups most frequently detected. Detergent metabolites, steroids, and plasticizers generally were measured at the highest concentrations.



Steroids, nonprescription drugs, and an insect repellent were the three chemical groups most commonly detected in susceptible streams. Detergent metabolites, steroids, and plasticizers generally were found at the highest concentrations.

Veterinary pharmaceuticals used in animal agriculture can enter streams through runoff or infiltration. A swine facility near the South Fork Iowa River, Iowa, is shown above. (Photograph by Doug Schnoebelen, U.S. Geological Survey)

Human and environmental effects: Knowledge of the potential human and environmental health effects of these 95 chemicals is highly varied; drinking-water standards or other human or ecological health criteria have been established for 14. Measured concentrations rarely exceeded any of the standards or criteria. Thirty-three are known or suspected to be hormonally active; 46 are pharmaceutically active. Little is known about the potential health effects to humans or aquatic organisms exposed to the low levels of most of these chemicals or the mixtures commonly found in this study.

Significance of findings: This study suggests that mixtures of pharmaceuticals, hormones, and other wastewater contaminants can occur at low concentrations in streams that are susceptible to various wastewater sources. It provides methodology and guidance for future monitoring and assessment of these types of environmental contaminants, and establishes the needed foundation for setting priorities for further study of sources, pathways and effects.

Future directions: Further analyses of these data, including relationships to specific source types, are ongoing. The Toxic Substances Hydrology Program is conducting research on the occurrence of organic wastewater chemicals in susceptible wells and drinking-water sources across the nation; assessments of antibiotics and antibiotic-resistant bacteria; the identification of wastewater indicators; and the development of new laboratory analytical capabilities, including sediment and fish tissue.

Additional information: These findings are based on "Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: A national reconnaissance," an article published in the March 15, 2002 issue of *Environmental Science & Technology,* v. 36, no. 6, pages 1202-1211. Data are presented in a companion USGS report, "Water-quality data for pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000" (USGS Open-File Report 02-94). These and other reports, data, and maps can be accessed on the Internet at http://toxics.usgs.gov.

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