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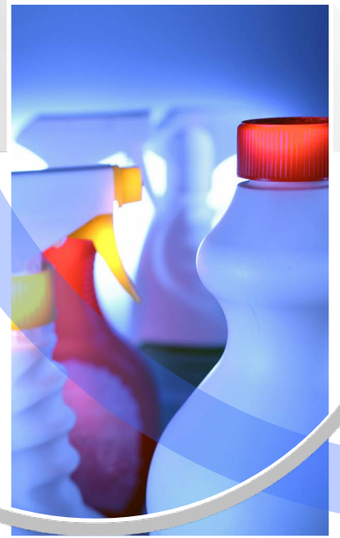

Pharmaceuticals and Personal Care Products

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Pharmaceuticals and Personal Care Products in the Environment

Pharmaceuticals and personal care products (PPCPs) are a diverse group of chemicals that include, but are not limited to, the following:

- all human and veterinary drugs;
- dietary supplements;
- other consumer products including fragrances, topical agents such as cosmetics and sunscreens, laundry and cleaning products; and
- all the "inert" ingredients that are part of these products.

Worldwide production of PPCPs ranges in quantities from kilograms to thousands of metric tons per year for some individual PPCPs.

There are three general categories of PPCP chemicals:

1. Pharmaceuticals - chemicals formulated into drugs for treatment of diseases (cure/mitigation), as chemo-preventatives (chemicals that reduce chances of disease or slow its onset; e.g., tamoxifen for breast cancer), or those that enhance health or structural functioning of the human body (e.g., by use of steroids and hormones). They also include diagnostic agents (e.g., X-ray contrast media), illicit, and veterinary drugs.
2. Protective Care Products - include cosmetics , fragrances, soaps, detergents, insect repellants, sun-screen agents, skin anti-aging preparations, and disinfectants.
3. Nutriceuticals - bioactive chemicals contained in nutritional supplements.

Pharmaceuticals and personal care products are introduced to the environment as pollutants in a variety of ways, some of which include: excretion by humans and domestic animals; intentional disposal of unneeded PPCPs into the sanitary sewer system; bathing or swimming; discharge from municipal sewage systems or private septic systems; leaching from landfills; runoff from agricultural areas; discharge of raw sewage from storm overflow events; accidental discharges within groundwater recharge area; and spray-drift from antibiotics used on food crops (see figure at right).

An initial study by the U.S. Geological Survey (USGS) in 2002 included 139 susceptible streams in 30 states. Quantifiable amounts of PPCPs were found in 80 percent of the streams and 93% of groundwater sampled. The most common pharmaceuticals detected were steroids and nonprescription drugs. Antibiotics, prescription medication, detergents, fire retardants, pesticides and natural and synthetic hormones were also found (see table at right).

Between 2004 and 2010, a California-specific study of PPCPs was conducted with samples collected from more than 1,000 groundwater wells. Groundwater samples were collected from within basins that account for 95% of all the groundwater used for public drinking-water supplies. Of the more than a dozen PPCPs included in the study, more than half were detected in drinking water wells. These detected PPCPs included: acetaminophen, caffeine, carbamazepine (used in the treatment of epilepsy and bipolar disorder, among others), codeine, p-xanthine (a caffeine breakdown product), sulfamethoxazole (an antibiotic), and trimethoprim (an antibiotic).

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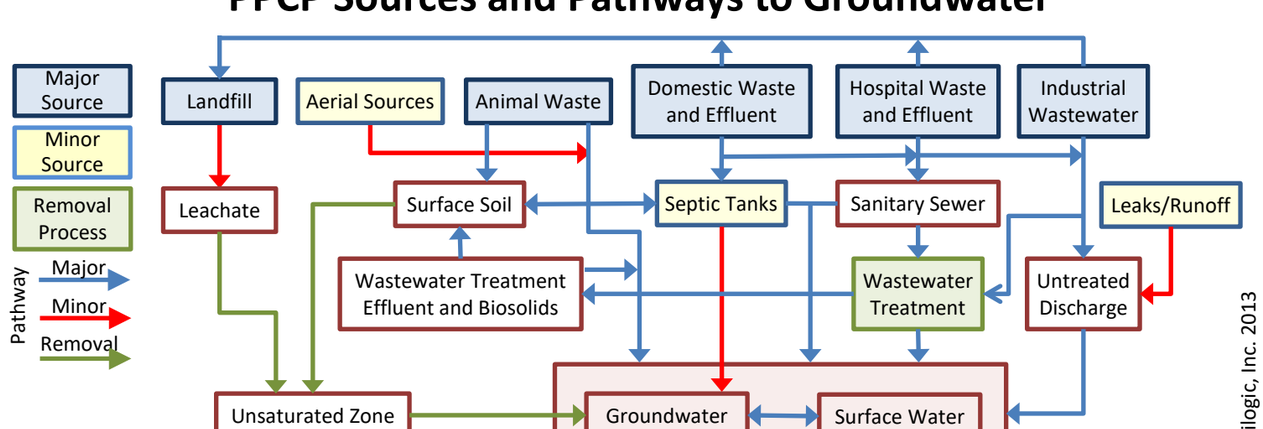
Common PPCPs and Their Uses

Substance Name	Use	Substance Name	Use
17alpha-estradiol	used in pharmaceuticals as an estrogenic hormone	Estriol	used in veterinary pharmaceuticals as an estrogenic hormone
2-Methoxyethanol	used in synthetic cosmetics, perfumes, fragrances, hair preparations, and skin lotions.	Estrone	used in veterinary pharmaceuticals as an estrogenic hormone
2-Propen-1-ol	used in the production of flavorings and perfumes.	Ethinyl Estradiol (17-alpha ethynyl estradiol)	used in veterinary pharmaceuticals as an estrogenic hormone
Acetaminophen	Prescription and non-prescription analgesic and antipyretic	Gemfibrozil	Prescription medication to lower lipid (triglyceride) levels
Albuterol	Prescription anti-asthmatic medication	Ibuprofen	a nonsteroidal anti-inflammatory drug (NSAID) used for pain relief, fever reduction, and swelling
Azithromycin	Prescription anti-biotic medication	Iopromide	Used as a contrast medium in brain computer tomography (CT) and CT pulmonary angiograms (CTPAs)
Caffeine	Non-prescription stimulant (coffee, colas, tea, etc.)	Meprobamate	Prescription anti-anxiety medication
Carbamazepine	Prescription mood stabilizer and anticonvulsant	Mestranol	an estrogenic hormone and is used in veterinary and human pharmaceuticals.
Chlorpropamide	Prescription medication used to treat Type 2 diabetes	nonylphenol ethoxylate	An endocrine disruptor and precursor to commercially important detergents
Codeine	Prescription analgesic and antitussive and opiod stimulant	Norethindrone (19-Norethisterone)	a progresteronic hormone used in pharmaceuticals.
Coprostanol	Metabolite of cholesterol	Phensuximide	seizures
Cotinine	Metabolite of nicotine (tobacco products)	Primedone	Prescription anti-convulsant to treat seizures and formerly cerebral palsy
Dehydro-Nifedipine	Metabolite of Nifedipine, a prescription anti-anginal and anti-hypertensive (blood pressure) medication	Quinoline	used as a pharmaceutical (anti-malarial) and as a flavoring agent.
Diazepam	Anti-anxiety medication	Sulfamethoxazole	veterinary and human prescription antibiotic
Dilantin	Anti-elliptic medication	Thiabendazole	Prescription and veterinary antihelminthic and agricultural antifungal
Diltiazem	Prescription antihypertensive and antiarrhythmic	Triclosan	disinfectant
Diphenhydramine	Non-prescription antihistimine	TCEP	Flame retardant and used in biochemistry and molecular biology applications
Equilenin	an estrogenic hormone also used in pharmaceuticals.	TCPP	Flame retardant used in rigid and flexible polyurethane foam
Equilin	an estrogenic hormone and is used in pharmaceuticals.	Trimethoprim	Prescription antibiotic
Erythromycin	used in pharmaceutical formulations as an antibiotic.	p-Xanthine	Metabolite of caffeine
Estradiol (17-beta estradiol)	an estrogenic hormone and is used in pharmaceuticals.	Warfarin	Prescription anticoagulant

PPCP Sources and Pathways to Groundwater



Lapworth, D.J., et al. "Emerging organic contaminants in groundwater: A review of sources, fate, occurrence" in Environmental Pollution, April 2012, Volume 163.