# Pharmaceuticals and Water Pollution

CLEAN WATER ACTION

## Drugs in California's Water


TerrenceOB/Sxc.hu

In 2002 the US Geological Study released the findings of a study of 139 streams in 30 states that detected non-prescription drugs in over 80% of the tested streams, and prescription antibiotics in about half of them.[i] This and other studies show a variety of drugs in sediment and aquatic species in San Francisco Bay and in several surface water sources used for drinking water around California, and pharmaceuticals at detectable levels in aquifers.[ii, iii] Some of the most commonly identified drugs in California's waterways include carbamazepine (mood stabilizer/ anticonvulsant); analgesics such as acetaminophen, ibuprophen, and codeine; sulfamethoxazole (antibiotic); hormones, and synthetic birth control such as ethynylestradiol.[iv, v]

## How Drugs Enter Water Resources

Drugs can enter water resources via direct discharge by pharmaceutical manufacturers, runoff of animal waste from agricultural facilities, through human excretion of unmetabolized medications, and by disposal of unused or out of date drugs down the drain or toilet, or when they end up in the trash and contaminate landfill leachate.[vi, vii]

Wastewater treatment plants are not meant to address complex chemicals, and some pharmaceuticals can get through the system and end up in water sources and even in treated drinking water.[viii] For instance, depression and anti-anxiety medications resulting from the discharge of treated wastewater have been found in the Colorado River, a drinking water source for millions of Californians. Eighteen pharmaceuticals have been detected in the South San Francisco Bay due to wastewater discharges, with sulfamethoxazole detected at concentrations approaching levels of concern for aquatic life.[ix] The Metropolitan Water District of Southern California, which serves 18.5 million people, has detected traces of a tranquilizer and an anti-epileptic drug in its drinking water.

Water treatment is extremely expensive, posing a serious financial burden on ratepayers and local governments. Orange County's sophisticated reverse osmosis system costs $15 a month for the 12,000 gallons used by a typical family of four (not including overhead costs). For this reason, more and more wastewater agencies are promoting pollution prevention strategies to stop contaminants from entering the waste stream.[x,xi]

# Environmental Impacts

While some medications break down quickly or are found at low levels, they are continually replenished and can cause continuous multi-generational exposures to aquatic organisms. The effects of these exposures are difficult to study because of the variety of complex mixtures that enter the environment. However, there is increasing evidence of serious impacts. Freshwater streams are particularly at risk because, unlike larger waterbodies, such as San Francisco Bay, they have less ability to dilute contaminant levels.[xii] Examples of environmental effects include:

• **Reproductive failure** – Synthetic estrogens in oral contraceptives have been linked to impaired reproduction in aquatic species due to changes in sex organs and sperm density, impaired eggs, endocrine disruption, and sex reversal.[xiii,xiv] Even plant life can be impacted. For instance, Ciprofloxacin can reduce the wet weight and number of fronds of duckweed.[xv]

• **Behavioral changes** – Antidepressants and anti-anxiety drugs at levels found in water sources can reduce reaction to predators, decrease sociability, and alter foraging habits that lead to faster depletion of available food.[xvi] All of these changes can decrease specie populations.

• **Bioaccumulation and interference with the food chain** – Some pharmaceuticals accumulate in the tissues of aquatic species. Carbamazepine, ditiazem (used to treat hypertension, angina, arrhythmia and migraine), and diphenhydramine (the antihistamine in Benadryl) are just a few of the drugs found in mussels in San Francisco Bay.[xvii] Erythromycin hydrate has been shown to inhibit green algae populations.[xviii] Effects in species so low on the food chain could result in serious repercussions for the ecosystems that depend on them.

# Human Health Risks

Humans are unintentionally exposed to drugs through drinking water, by eating contaminated fish or produce irrigated with contaminated water, and through bathing or swimming.[xix] The few studies on human impacts stress the fact that these exposures are well below therapeutic levels and are unlikely to pose a serious public health threat. However, these same studies acknowledge that there are many gaps in the data on human effects that must be addressed before we can rely on such assurances. The potential impacts on human health include:

- Subtle effects resulting from long term exposures over many years, even at low levels;
- Multigenerational changes in gene expression that produce delayed effects;
- Impacts of chemical mixtures, both short and long term;
- Potential harm to vulnerable populations such as fetuses, children, pregnant women or people with compromised immune systems;
- Compounding the existing problem of antibiotic resistant bacteria or "super bugs" due to exposure to pharmaceutical antibiotics and antimicrobial agents.

In addition to these threats, studies have shown that exposure to small amounts of various drugs can effect embryonic kidney cells, as well as human blood and breast cancer cells.[xx]

## Endnotes


[i]Kolpin, Dana et al. (2002) Pharmaceuticals, hormones and other organic wastewater contaminants in U.S. Streams, 1999-2000: A National Reconnaissance, Environmental Science and Technology v. 36: 1202-1211.

[ii]Donn, Jeff, Martha Mendoza, and Justin Pritchard, An AP Investigation: Pharmaceuticals Found in Drinking Water, http://hosted.ap.org/specials/interactives/pharmawater_site/day1_04.html,

[iii]Fram, Miranda S. and Kenneth Belitz (2011) Occurrence and concentrations of pharmaceutical compounds in groundwater used for public drinking-water supply in California, Science of the Total Environment v. 409: 3409-3417

[iv]Ibid., Guo, Y.Carrie et al. (2010) Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California, The National Water Research Institute

[v]Harrold, K.H. et al. (2009). Pharmaceutical Concentrations in Wastewater Treatment Plant Influent and Effluent and Surface Waters of Lower South San Francisco Bay. SFEI Contribution 549. San Francisco Estuary Institute, Oakland, CA

[vi]Emerging Contaminants Workgroup of the Santa Clara Basin Watershed Management Initiative (2005). Discussion Paper on Pharmaceutical Disposal to Sewer Systems. http://www.scbwmi.org/PDFs/WMI_Pharm_White_Paper_FinalMarch05.pdf,

[vii]California Department of Toxic Substances Control, Toxicological Issues Associated with PPCPs, www.dtsc.ca.gov/AssessingRisk/PPCP/PPCPTox.cfm

[viii]Stackelberg, P.E. et al. (2004) Persistence of pharmaceutical compounds and other organic wastewater contaminants in a conventional drinking-water-treatment plant, Sci Total Environ. v. 329(1-3): 99-113,

[ix]Harrold, et al

[x]Emerging Contaminants Workgroup…Discussion Paper.

[xi]APECWater, Removing Pharmaceuticals from Water Doesn't Come Cheap or Easy, www.freedrinkingwater.com/water-news/remove-pharmaceuticals-from-water-not-cheap.htm

[xii]Klosterhaus, S.L. et al. (2013) Method validation and reconnaissance of pharmaceuticals, personal care products, and alkylphenols in surface waters, sediments, and mussels in an urban estuary, Environment International v. 54: 92-99.

[xiii]Ibid.

[xiv]Barber, Larry B. et al. (2011) Effects of biologically-active chemical mixtures on fish in a wastewater-impacted urban stream. Science of the Total Environment v. 409: 4720-4728.

[xv]Harrold, et. al.

[xvi]Brodin T. (2013), Dilute Concentrations of a psychiatric drug alter behavior of fish from natural populations. Science v. 339: 814-15.

[xvii]Klosterhaus, et. al.

[xviii]Harrold, et. al.

[xix]Department of Toxic Substances Control, www.dtsc.ca.gov/AssessingRisk/PPCP/PPCPTox.cfmxx Associated Press, http://hosted.ap.org/specials/interactives/pharmawater_site/day1_04.html



**Questions?** *Andria Ventura, Program Manager, aventura@cleanwater.org or 415.369.9166*