National Water Research Institute

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New NWRI Study Finds Low Levels of Pharmaceuticals and Other Unregulated Chemical Compounds in Water Supplies

NWRI released a final project report today that evaluated the presence and fate of constituents of emerging concern (CECs), such as pesticides, pharmaceuticals, and components of personal care products, in three major drinking water sources for over 25-million people in Southern California. The three water sources include the State Water Project, Colorado River, and Santa Ana River.

The NWRI report, entitled "Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California," can be downloaded at www.nwri-usa.org/CECs.htm. It was prepared by researchers at the Metropolitan Water District of Southern California (MWD) and Orange County Water District (OCWD) who conducted a 2-year, $300,000 study with the objective of better understanding the presence and impact of CECs in our water supplies at extremely low levels.

"The detection of CECs at very low levels in our water supplies is an emerging issue," said Jeff Mosher, NWRI Executive Director. "This study provides us with a better understanding of the frequency and levels of occurrence of CECs in three major water supplies serving Southern California. With this information, we can better assess any possible impacts from the presence of CECs in our water supplies."

"CECs" is a term used to include a broad range of unregulated chemical components found at trace levels in many of our waters, including surface water, drinking water, wastewater, and recycled water. They include the pharmaceuticals that people use to treat illnesses and components of personal and household products, like shampoos, detergents, and pesticides. CECs enter our water sources by flushing unused medications, using personal and household products, excreting unabsorbed medications into the wastewater collection systems, and spills into water or wastewater collection systems.

The research team took water samples from the three water sources at 32 locations, ranging from upstream of the City of Sacramento to down south in Orange County, California, as well as from locations along the Colorado River in Arizona and Nevada. Sampling took place between April 2008 and April 2009.

Altogether, out of the 49 CECs that were evaluated in this study, the research team detected 27 CECs in water samples from the three water sources, while 22 were not detected in any of the sources.

The detected CECs were found at very low levels – levels that are millions of times smaller than a pharmaceutical dose. CEC detections are reported in "nanograms per liter" (ng/L). A nanogram is one one-billionth of a gram, and nanograms per liter are equal to "parts per trillion" (ppt). For example, one ppt equates to one drop of water in 20 Olympic-sized swimming pools, or about one second in 32,000 years.

The ability to detect CECs at very low levels in water is a relatively new breakthrough in science. It is so new, in fact, that the analytical methods developed to detect CECs are not standard methods (that is, methods approved for regulatory purposes), which means that the methods may vary from laboratory to laboratory. All three laboratories that participated in the study used analytical methods that were either previously published or slightly modified versions, and incorporated inter-laboratory comparisons and extensive quality assurance/quality control protocols to ensure high-quality data.

The study narrowed its focus to analyzing for the presence of 49 CECs, which were selected based on common occurrence, the ability to either be reduced or to remain stable in the natural environment, and other criteria. An example of CECs that were selected to be analyzed include flame retardants such as TCEP, detergent metabolites such as 4-n-Nonylphenol, antibiotics such as ciprofloxacin, anti-convulsants such as carbamazepine, hormones such as testosterone, and herbicides such as atrazine.

The sampling and analysis results included:

State Water Project - An engineered water storage and delivery system of reservoirs, aqueducts, and pumping plants that delivers water throughout California, including Southern California.

- Twenty-one CECs were detected in State Water Project samples, typically at levels below 30 ng/L.
- The most frequently detected CECs were carbamazepine, diuron, and sulfamethoxazole (at 88-percent detection frequencies), followed by primidone and TCEP (70 percent).

Colorado River - This river flows from Colorado through Utah, Nevada, and Arizona; water is imported to Southern California via the Colorado River Aqueduct.

- Twelve CECs were detected in Colorado River surface water samples, typically at levels below 20 ng/L.
- The most frequently detected CECs in the surface water samples were carbamazepine (89-percent detection frequency) and sulfamethoxazole (84 percent).
- Sixteen CECs were detected in the wastewater treatment plant effluent samples from the Colorado River watershed, with average levels on the order of a hundred to several hundred nanograms per liter.
- The most frequently detected CECs in the wastewater effluent samples were azithromycin, caffeine, carbamazepine, ciprofloxacin, DEET, diclofenac, dilantin, diuron, gemfibrozil, primidone, sulfamethoxazole, and TCEP (at 100-percent detection frequencies).

Santa Ana River - This river flows from the San Bernardino Mountains to the Pacific Ocean through three counties in Southern California. Flow from the SAR is diverted and used for groundwater recharge in Orange County, California.

- Twenty-two CECs were detected in river and tributary samples from the Santa Ana River. Typical concentrations varied from 2 to 200 ng/L.
- The most frequently detected CECs in the river and tributary samples were caffeine and TCEP (at 100-percent detection frequencies), followed by DEET and diuron (98 percent).
- Twenty CECs were detected in the wastewater treatment plant effluent samples from the Santa Ana River watershed, with average levels on the order of a hundred to several hundred nanograms per liter.
- The most frequently detected CECs in the wastewater effluent samples were carbamazepine, dilantin, diuron, primidone, and sulfamethoxazole (at 100-percent detection frequencies).

It should be noted that each of these water sources is impacted in varying degrees by treated wastewater discharges, agricultural runoff, recreation, and other activities that may account for the presence of CECs.

The ability to detect a compound does not necessarily translate to human health concerns. To date, no adverse health impacts have been documented from exposure to the extremely low concentrations of CECs found in water supplies. In fact, current research indicates that individuals could consume 50,000 eight-ounce glasses of water per day without any experiencing any health effects due to trace levels of CECs.

Also included in this study was an evaluation of the fate and transport of CECs. The term “fate and transport” refers to what happens to a CEC as a result of its potential to be transported, transformed, or destroyed in a watershed. The research team found that CECs were attenuated (or reduced) in the natural environment. A possible cause for the attenuation of some CECs (such as the anti-convulsants carbamazepine and primidone) was dilution with other source waters, whereas for other CECs (such as gemfibrozil and sulfamethoxazole), the cause was natural degradation processes, such as biodegradation, photolysis, and sorption.

In addition, the research team concluded that the use of wetlands to remove nitrate from the water also appears to be an effective means to remove some CECs to varying extents. For example, the antibiotic azithromycin was completely attenuated from water sampled at the Prado Wetlands (part of the Santa Ana River watershed), while caffeine, gemfibrozil, ibuprofen, sulfamethoxazole, and acetaminophen were often highly attenuated (42 to 100 percent).

Significant information was obtained from this study on the occurrence, fate, and transport of CECs in three water sources in California. However, this study is among the first of such efforts currently being undertaken by the water and wastewater community to better understand the presence of CECs in our water sources.

To move forward on developing a better understanding of CECs, the study provided recommendations that future research, such as developing standardized analytical methods to better evaluate water quality data on CECs and to include monitoring wells in future sampling efforts to understand the occurrence of CECs in groundwater.

More information about the study’s findings, including analytical methods used and detailed sampling results from each of the sampling locations of the three water sources, can be found in the NWRI project report, which is available for download at www.nwri-usa.org/CECs.htm.

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