



The golfer is a 154-pound adult who plays on a course irrigated with tertiary-treated recycled water. The golfer plays twice a week, with each round lasting 4 hours; he/she wears a short-sleeve shirt and shorts and 10 percent of his/her hands, forearms, and lower legs are wet with recycled water during the entire round of golf. During play the golfer ingests 1 milliliter (mL) of recycled water per hour from handling and cleaning golf balls. The exposures evaluated include absorption through the skin and incidental ingestion.

This is a high estimation of the amount of water to which a typical golf course user could be exposed. This is done purposely to build extra margins of safety into the risk assessments in this study (see reverse). The scenario represents not only golfers but any other adults that frequent the course as a golfer would, such as caddies.

**Explaining the Chart:** The chart on the reverse is divided into four columns: column 1 lists ten Pharmaceuticals & Personal Care Products (PPCPs); column 2 explains a little about what these compounds are and how one might come into contact with them in the normal course of daily life; column 3 compares “acceptable”<sup>1</sup> concentrations of these PPCPs to what is actually measured<sup>2</sup> in tertiary- or secondary-treated recycled water. Finally, using actual concentrations of PPCPs found in recycled water, column 4 shows the number of years that it would take, under the above scenario, for the golfer to be exposed to the equivalent of a dose (or normal daily intake) of the compound from conventional uses.

**Interpreting the Numbers:** Let’s put it all together, using Ibuprofen as our example. Ibuprofen is an over-the-counter (OTC) non-steroidal anti-inflammatory pain reliever (column 2), such as Advil. Acceptable (safe) concentrations of Ibuprofen in recycled water used to irrigate landscaping, such as a golf course, have been calculated to be 1,600 micrograms per liter (ug/l) (column 3); actual concentrations measured in tertiary- or secondary-treated recycled water systems are typically less than or equal to 1/2 microgram per liter, which is far below levels considered safe. At actual concentrations, the golfer could enjoy playing, under the above exposure scenario, for 26,000 years before being exposed to the equivalent of one Advil tablet (column 4).

**How much is a microgram?** One microgram per liter is often expressed as one part per billion and is roughly equivalent to one sugar cube in an Olympic size swimming pool.

**Why have only ten PPCPs been listed?** There are currently hundreds of Pharmaceuticals & Personal Care Products (PPCPs) that can be detected in varying concentrations throughout the environment. For the purposes of this study, 10 chemicals were chosen for their associated health risks and/or recognizability. They were carefully selected to be representative of the PPCPs that are present in most recycled water used for irrigation purposes.

For more information, visit:  
[www.athirstyplanet.com](http://www.athirstyplanet.com)

This research and public information project (WRF-09-07) was funded by the WateReuse Research Foundation and participating utilities.

© Copyright 2011 by the WateReuse Research Foundation. All rights reserved. Permission to reproduce must be obtained from the WateReuse Research Foundation.

<sup>1</sup> Acceptable concentrations are calculated concentrations at which adverse health effects are not expected from exposure to recycled water. In other words, levels at which contact with the water is deemed to be safe.

<sup>2</sup> Actual concentrations are the 90th percentile concentrations presented in Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water; Recommendations of a Science Advisory Panel. Final Draft. California State Water Resources Board, June 25, 2010. This means that in a review of available studies in which PPCPs were measured in recycled water, 90 percent of the measured concentrations were equal to or less than the concentrations presented here.

(1) Pharmaceuticals & Personal Care Products - PPCP	(2) How Used/Where Found	(3) Acceptable (safe) vs. Actual Concentrations ug/l	(4) Relative Exposure at Actual Concentrations
<b>Ibuprofen</b> 	Over the counter (OTC) non-steroidal anti-inflammatory pain reliever (NSAID)	Acceptable = 1,600 Actual = 0.5	Our golfer could enjoy his/her game for 26,000 years before being exposed to the equivalent of one Advil tablet
<b>17-beta estradiol</b> 	Prescription hormone replacement	Acceptable = 0.15 Actual = 0.0084	After 13,000 years at the course, the golfer would be exposed to the equivalent of one dose of this hormone as it is typically prescribed
<b>Fluoxetine</b> 	Prescription antidepressant	Acceptable = 350 Actual = 0.031	After 91,000 years on the links, our golfer will have been exposed to the fluoxetine equivalent of one Prozac tablet
<b>Sulfa-methoxazole</b> 	Antibiotic commonly used to treat urinary tract infections or sinusitis	Acceptable = 190,000 Actual = 1.4	After 1,100,000 years on the course, the golfer will have been exposed to the equivalent of one prescription dose of this antibiotic
<b>PFOS</b> 	Man-made fluorosurfactant formerly found in Scotchgard, numerous stain repellents, textiles, paper, and leather; in wax, polishes, paints, varnishes, and cleaning products for general use; in metal surfaces, and carpets	Acceptable = 1,800 Actual = 0.09	Our golfer can roam the links for 29 years before he/she reaches the same exposure to PFOS it is estimated he/she receives in one day from other environmental factors
<b>Bisphenol A</b> 	Commonly called BPA; an organic compound known to be estrogenic; used to make polycarbonate plastic (water bottles) and epoxy resins, along with other applications	Acceptable = 2,500 Actual = 0.29	After 8.9 years on the course, the golfer will be exposed to the equivalent dose of BPA it is estimated he/she ingests from food in just one day
<b>DEET</b> 	N,N-diethyl-meta-toluamide (DEET) is the active ingredient in many insect repellent products	Acceptable = 38,000 Actual = 1.5	After golfing for 190 million years, the golfer will be exposed to the equivalent of one application of Deep Woods Sportsman Off to arms, hands and lower legs
<b>Triclosan</b> 	Antibacterial agent found in soap, toothpaste, deodorant; and is infused in an increasing number of consumer products, such as kitchen utensils, toys, bedding, socks, and trash bags	Acceptable = 2,700 Actual = 0.49	It would take 6,600 years on the course before our golfer is exposed to the equivalent amount of Triclosan that he/she would get from washing his/her hands with anti-bacterial soap for 30 seconds
<b>Acetaminophen</b> 	OTC pain reliever	Acceptable = 150,000 Actual = 0.55	It would take 1,700,000 years of golfing for this player to be exposed to the equivalent of one Extra-strength Tylenol tablet
<b>Caffeine</b> 	Stimulant found in coffee, tea, chocolate, and other food items	Acceptable = 85,000,000,000 Actual = 0.90	To be exposed to the same amount of caffeine found in a typical cup of coffee, our golfer will have to play for 250,000 years