

# Attenuation of Pharmaceuticals, Personal Care Products, and Endocrine-disrupting Compounds by Golf Courses Using Reuse Water

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## Objectives:

1. To understand the fate and transport of PPCP/EDCs in golf courses when reuse water is used as the sole source of irrigation water.
2. To evaluate the capacity of turfgrass as a biofilter to remove PPCP/EDCs in reuse water.
3. To extend knowledge to stakeholders and reduce the uncertainty of how long-term use of reuse water for irrigation may impact groundwater quality.

**Start Date:** 2008

**Project Duration:** two years

**Total Funding:** \$60,000

Golf courses represent excellent sites for examining the potential migration of pharmaceutical personal care products (PPCPs) and endocrine-disrupting compounds (EDCs) toward the water table. Recently, arid southwestern cities like Las Vegas, Phoenix, and Palm Springs have been installing distribution systems that allow golf courses to utilize reuse water. Additionally, reuse water is sometimes supplied to infiltration basins that augment natural recharge to phreatic aquifers.

Assessing and evaluating the vadose-related attenuation processes may help determine whether accumulation of these compounds occurs in shallow groundwater systems. Many studies over the last two decades show that turfgrass is extremely effective in retaining and biodegrading trace contaminants such as many pesticides. In particular, research shows that the thatch layer, which is the matted layer of grass debris and soil organic matter near the surface, is a highly active "biofilter." This project is investigating the fate and transport of PPCP/EDCs to determine the effectiveness of turf in mitigating their vertical movement (i.e., leaching).

An inter-laboratory comparison of sample analyses has been completed. The results from the two laboratories are fairly consistent and are considered acceptable. Additional samples will be sent to both labs for comparative analysis and evaluation. Aerobic and anaerobic soil conditions were evaluated for their effectiveness in degrading PPCPs. Most PPCPs were stable in anaerobic conditions versus being attenuated in aerobic soil conditions.

Drainage has been observed in all 12 of the high leaching fraction lysimeters



Three of the 17 compounds have been detected in the drainage samples that were selected based on meeting pore volume displacement goals.

while less than half of the low leaching fraction lysimeters are draining. Three of the 17 compounds have been detected in the drainage samples that were selected based on meeting pore volume displacement goals. The three are bisphenol A, primidone, and sulfamethoxazole. It is possible that the bisphenol detections are from equipment contamination and the research team is evaluating that possibility.

The field plot study is almost completed. There are two soil types - sandy loam and loamy sand - and two irrigation rates - low and high - being studied. Early results are:

### Sandy loam soil

The same four PPCPs were detected in the low and the high irrigation rates, but generally at higher concentrations under high irrigation. They are: primidone, sulfamethoxazole, trimethoprim, and carbamazepine. Removals through the soil were about 59, 99, 87 and 67%, respectively.

### Loamy sand soil

Three of the four PPCPs detected in the sandy loam soil leachate were also

detected in loamy sand leachate at the low irrigation rate. All four were detected at the high irrigation rate. Removals were about 77 - 88%.

Initial data from all field sites is being collected and analyzed. Equipment issues at Industry Hills have been an ongoing challenge for data and sample collection. Financial hardships at the course in Palm Springs have led to a temporary delay in data and sample collection.

The research project is on schedule and is scheduled for completion in July 2010. The research team is looking to extend some of the sampling of the soil column experiment and golf course field sites past the July 2010 deadline. Achieving the soil/water balance equilibrium would be of interest in order to get a complete picture of the degradation and drainage flux parameters.

## Summary Points

- Aerobic and anaerobic soil conditions were evaluated for their effectiveness in degrading PPCPs. Most PPCPs were stable in anaerobic conditions versus being attenuated in aerobic soil conditions.
- Three of the 17 compounds have been detected in the drainage samples that were selected based on meeting pore volume displacement goals.
- Primidone, sulfamethoxazole, trimethoprim, and carbamazepine were detected in the low and high irrigation rates, but generally at higher concentration under high irrigation. Removals through the sandy loam soil were about 59, 99, 87, and 67%, respectively.
- Three of the four PPCPs detected in the sandy loam soil leachate were also detected in loamy sand leachate at the low irrigation rate. All four were detected at the high irrigation rate. Removals were about 77 - 88% in loamy sand soil.