

## Urban Pesticides Risk Assessment and Management Review

### QUANTITATIVE ANALYSIS OF OVER 20 YEARS OF GOLF COURSE MONITORING STUDIES

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**Abstract**—The purpose of the present study was to comprehensively evaluate available golf course water quality data and assess the extent of impacts, as determined by comparisons with toxicologic and ecologic reference points. Most water quality monitoring studies for pesticides have focused on agriculture and often the legacy chemicals. There has been increased focus on turf pesticides since the early 1990s, due to the intense public scrutiny proposed golf courses receive during the local permitting process, as well as pesticide registration evaluations by the U.S. Environmental Protection Agency under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Results from permit-driven studies are frequently not published and knowledge about them is usually not widespread. Forty-four studies involving 80 courses from a 20-year period passed our quality control and other review criteria. A total of 38,827 data entries (where one analysis for one substance in one sample equals a data entry) from pesticide, pesticide metabolite, total phosphorus, and nitrate analyses of surface water and groundwater were evaluated. Analytes included 161 turf-related pesticides and pesticide metabolites. Widespread and/or repeated water quality impacts by golf courses had not occurred at the sites studied, although concerns are raised herein about phosphorus. Individual pesticide database entries that exceed toxicity reference points for groundwater and surface water are 0.15 and 0.56%, respectively. These percentages would be higher if they could be expressed in terms of samples collected rather than chemicals analyzed. The maximum contaminant level ([MCL]; 10 mg/L) for nitrate-nitrogen was exceeded in 16/ 1,683 (0.95%) of the groundwater samples. There were 1,236 exceedances of the total phosphorus ecoregional criteria in five ecoregions for 1,429 (86.5%) data entries. (This comparison is conservative because many of the results in the database are derived from storm flow events.) Thus, phosphorus appears to present the greatest water quality problem in these studies. Pesticides detected in wells had longer soil metabolism half-lives (49 d) compared with those not detected (22 d), although the means were not significantly different. Environ. Toxicol. Chem. 2010;29:1224–1236. # 2010 SETAC

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[All Supplemental Data may be found in the online version of this article. \* To whom correspondence may be addressed ([ets@ets-md.com](mailto:ets@ets-md.com)). Published online in Wiley InterScience ([www.interscience.wiley.com](http://www.interscience.wiley.com)).]