Architectural Approaches for Biological Filtration of Nutrients In Golf Course Runoff Water

Eric Miltner, Gwen Stahnke, William Johnston, and Geoffrey Rinehart
Washington State University

Objectives:
To monitor the effectiveness of biological filtration techniques that were intentionally incorporated into the design and construction of a golf course. Nitrogen and phosphorus concentrations in soil solution and surface water are being monitored in several locations, including:
1. moderately sloped drainage basins in fertilized fairways
2. low-maintenance grass buffers, bioswales, and low-lying "wet cells" that seasonally contain standing water
3. constructed wetlands and a natural central wetland and lake that capture surface drainage from most of the golf course.

Start date: 2002
Project duration: 2 years
Total funding: $17,700

Construction of golf courses has become much more scrutinized, monitored, and regulated over the past decade. Much of this attention relates to the potential environmental impact of a proposed development. Irrigation water requirements and water quality have been at the forefront for quite some time. Issues now receiving greater scrutiny include preservation of wildlife habitat, wetland preservation and mitigation, and storm water retention. In addition, in the Pacific Northwest in particular, sand topdressing and/or building courses with extensive sand caps to allow for winter play is becoming the norm. Recent innovations in golf course design and engineering are attempting to address both environmental quality and playability concerns. Some of the most recent innovations include surface features such as constructed wetlands, buffer strips, and graded filter strips or "bioswales" designed to filter nutrients from water before it leaves the site. Although constructed wetlands are not a new idea, applying this technology for golf course runoff filtration is. This project studies the effectiveness of this technology.

This project is being conducted at a golf course on the Olympic Peninsula. A natural 18-acre lake surrounded by wetland is the drainage basin for 16 of the golf course's 18 holes. The entire golf course was constructed with a 6 to 10 inch deep sand cap. In addition, "bioswales" (mounded berms), "wet cells" (low-lying graded areas that seasonally contain water) and artificial wetlands were included at edges of fairways and in roughs. These features were designed to intercept runoff water and allow for uptake of nutrients from the water by plants and soil microorganisms. Soil solution samplers were installed up gradient, within, and down gradient from selected bioswales, wet cells, and wetlands. Samples are collected periodically and analyzed for inorganic nitrogen and orthophosphate (soluble phosphorus), two potentially important pollutants of surface and ground water.

Grass buffer and artifical wetland designed to filter contaminants from water before flowing into natural wetland and lake.

On 13 different dates between May 2002 and November 2003, 314 individual samples were collected. Most of these (256) contained below 1 part per million (ppm) nitrate-nitrogen. Only 14 had nitrate levels above the EPA drinking water threshold of 10 ppm. Of the 260 samples analyzed for orthophosphate, 211 were below the surface water quality threshold of 0.05 ppm. Some samples indicated accumulation of nitrate-N in down slope areas, including bioswales and un-maintained buffers located between fairways and constructed wetlands. This indicates that soil solution and nitrate is accumulating in low-lying areas, as predicted. We have installed additional samplers that we hope will lead to a better understanding of these nitrate accumulations. Nitrate concentrations have been dramatically lower in locations further down gradient from these accumulations (within wetlands or in soil on banks of lake). This indicates that effective filtering may be occurring in these features as designed. Sampling will continue through the spring of 2004.

Summary Points:

- For the vast majority of samples, nitrate-nitrogen and orthophosphate concentrations have been well below the recognized water quality thresholds.
- Nitrate-nitrogen concentrations have been elevated in certain low-lying temporary collection areas. Down gradient from these areas, concentrations have always been greatly decreased in comparison.
- The sand-capped fairways do not appear to be creating high mobility potential for nitrogen or phosphorus.
- Bioswales, buffers, and wetlands constructed on the course appear to be helping to maintain high surface water quality in the natural lake.