Similar to what was observed for total nitrogen, the concentration of total phosphorus in the water decreased during the early stage operation. Vegetation reestablished on the surface was the main cause of the reduction of total phosphorus concentrations in the surface water. The recovery of the surface cover reduced erosion of soil particles and reduced transport of nutrients to surface water streams.

Concentrations of total nitrogen and total phosphorus were found significantly greater during golf course construction than during the pasture stage. The increase of eroded soils carried particle-bound nitrogen and phosphorus to the stream. Inflow and outflow total-nitrogen-to-total-phosphorus ratios of the averages, at the three studied stages, were always lower than 8, which indicated limiting nitrogen availability in the streams.

The study of nitrogen and phosphorus in surface water is extremely important because excessive amounts of both nutrients in natural streams lead to eutrophication problems in lakes and water bodies. This study indicates that, if course management is operated adequately, the surface water quality in a golf course-dominated watershed can be returned back to its original conditions. **GCI**

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IMPACT ON THE BUSINESS

Manage your image with proactive research

By Dean Baker, CGCS, and Buckley Brockmann, assistant superintendent, Kinston Country Club

Kinston (N.C.) Country Club is an 18-hole, traditional-style golf course – established in 1924 – that has undergone expansion, renovation and layout changes throughout the years. In 1999, the 130-acre course became a Certified Audubon Cooperative Sanctuary.

While the club was seeking certification, there was a focus in the news and state legislature about pollutants in the nearby Neuse River. The club's staff was concerned about a possible negative image as a pollution source because the club is in the Neuse River basin and uses fertilizers.

Audubon certification was a step in the right direction for the club's image as an environmental steward, but certification didn't provide documentation that would support the course's maintenance practices that protect and ensure water quality. That was about to change.

In 1998, the golf course maintenance staff implemented a proactive water monitoring practice to monitor surface water surrounding the course. Along two edges of the golf course, city storm drain water and surface water combine and flow through a drainage ditch almost 10 feet wide and 8 feet deep. On an average day, there's about a foot of water in the ditch. During a heavy rain, water may rise to 6 feet. Ultimately, this water drains into a creek that drains into the Neuse River.

The maintenance staff collected water samples at two sites – a point where the water enters the course at the start of the drainage ditch and a point where the water exits the course before entering the creek. All samples were sent to North Carolina State University for analysis. Early test results showed the water leaving the course seemed to contain lower concentrations of nitrogen compared to the water entering the course. Therefore, the disciplined and methodical collection of the water samples appeared to be worthwhile; however, the water monitoring program didn't provide long-term data to prove the golf course was filtering water in the ditch.

Fortunately, the crop science department at N.C. State also was concerned about water quality and, specifically, the effects of nitrate leaching – the movement of nitrates through the soil. Many forms of nitrogen are present on a golf course, and depending on the circumstances, some may be considered a water pollutant. A form of nitrogen that receives the primary attention for environmental impacts is nitrate. High levels of nitrate may have environmental impacts such as promoting algae growth. Research had been done about the effects of nitrate leaching in soils that included cool-season turfgrasses, but little research had been done in an environment that supported mostly warm-season varieties of turfgrass.

N.C. State scientists intended to conduct research on nitrate leaching in soils associated with warm-season turfgrass. They wanted an active, real-world environment in which to conduct research. One of two golf courses they chose was Kinston Country Club because of the water quality monitoring already started by the club's staff.

First, N.C. State researchers installed devices called lysimeters around the course to measure the soil's nutrient levels near grass root zones. They also drilled shallow wells to measure levels in the groundwater. Additionally, the research team and Kinston's staff continued to sample the surface water surrounding the course. The idea was that the water moving through and under the golf course's grounds would be contributing to the water in the ditch and Neuse River.

N.C. State scientists found the water leaving the golf course contained lower nitrate levels than the water entering the course. The reduction of nitrate levels was partly because of the groundwater seeping into the ditch from the golf course and diluting the surface water in the ditch. Also, vegetation left to grow taller, thicker and in a more natural state along the edges of the ditch served as a riparian buffer strip and helped to filter runoff from rain and irrigation.

These natural areas and buffer strips created during the Audubon certification process helped the environment by creating a habitat and removing pollutants before they reached the groundwater and surface water. Having the findings of a well-recognized and highly respected university show the course wasn't hurting the environment was invaluable.

Ultimately, the proactive approach Kinston staff took helped change local public opinion of the golf course. A little extra work brought N.C. State to the club and added some legitimacy to the club's claim that it wasn't polluting, but actually helping to improve water quality.

On top of that, some important research took place, and Kinston staff established a great working relationship with N.C. State. It feels good to know that our efforts helped change the perception of our profession and contributed to meaningful research. GCI