

# Measuring Nutrient Losses via Runoff from an Established Golf Course

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## Objectives:

1. Compare nutrient loading via surface water runoff from a new golf course versus the site's previous native prairie condition.
2. Investigate the new golf course's impact on surface water quality during construction and during golf course operations.

**Start Date:** 1998

**Project Duration:** 6 years

**Total Funding:** \$148,155

Kansas State University in cooperation with Jim Colbert, PGA Tour, GCSAA, and various alumni built a 27-hole championship golf course, Colbert Hills Golf Course, near Manhattan, Kansas. The construction and operation of the golf could possibly impact the surface water quality of nearby streams. Sediment washed away from the construction site would eventually flow into rivers and lakes and cause ecological damage.

We set up four monitoring stations on Little Kitten Creek (the major stream) and its tributaries to collect water samples, measure runoff discharges, and collect precipitation data. Water samples were tested for total nitrogen, total phosphorous, and sediment concentrations. Surface water runoff amounts were studied so that mass transport of nutrients and sediment could be analyzed.

In the past year, we continued our previous nutrient runoff research by collecting more samples and analyzing data. Unlike year 2002, we had average precipitation this year. We thus were able to collect a good number of samples to profile stream water quality during golf course operation this year. We divided the data set into three subsets, namely pre-construction (native conditions), during construction, and during operation.

At the main stream leaving the golf course, 28, 138, and 136 surface water samples were collected for the three periods. Data analysis showed that golf course construction has the greatest impacts on surface water quality with average concentrations of 3.94 mg/L, 0.93 mg/L, and 2,955 mg/L for total N (TN), total P (TP), and sediment (TSS) respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction period.

During operation, sediment content was brought down significantly to an average of 750 mg/L, slightly higher than that of the native prairie condition. The average concentrations of TN and TP were 2.09 mg/L and 0.64 mg/L, much lower than those in the construction period, but still about twice as much as those in the native prairie condition.



Sampling set-up where the stream enters the golf course.

Nutrients in streams under native prairie condition and during construction are thought to be from the input of rainfall and sediment eroded from fertile topsoils. During golf course operation, fertilizer application is another source of nutrients in streams. At the main stream leaving the golf course, correlation coefficients between TSS and TN and between TSS and TP are 0.87 and 0.88 in the pre-construction period, 0.72 and 0.91 during construction, and 0.23, 0.58 during operation.

The excellent correlation between TSS and TN,TP at pre-construction and during construction periods explains that the magnitudes of concentration of TN and TP change with the magnitude of TSS. Indeed, particulate nitrogen and phosphorus absorbed by sediment particles and brought down to streams in runoff events are the major source of nutrient in streams in these periods. The smaller correlation coefficient during golf course operation indicates that human interference (fertilizer application) breaks down the inherent

correlation between TSS and TN, TP. Human input is significant.

Further analysis shows that there are direct connections between fertilizer application and concentration of TN and TP in streams. Although these connections are not so obvious in most cases, there are cases that clearly indicate the amount and timing of fertilizer application are to be blamed. This is the case when a significant amount of fertilizer is applied over a large area and significant rainfall comes shortly after the application. However, only a few samples have TN great than 10 mg/L, a drinking water standard. We therefore believe that golf course operation, as a whole does not pose immediate threat to the aquatic system.

Using preliminary stream flow relationships, we were able to determine the surface water runoff amounts and the mass amounts of nutrient transported off-site. The rates of nutrient transport for native conditions were similar with those in the adjacent Konza Prairie Research Area. The rate of nutrient transport during construction was three to four times that under native conditions, which was consistent with the estimation of sediment yields.

## Summary Points

- Data analysis showed that golf course construction has the greatest impacts on surface water quality with average concentrations of 3.94 mg/L, 0.93 mg/L, and 2,955 mg/L for total N (TN), total P (TP), and sediment (TSS) respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction period.
- Nitrogen and phosphorus absorbed by sediment particles and brought down to streams in runoff events are the major source of nutrient in streams.
- Only a few samples have TN great than 10 mg/L, a drinking water standard. We therefore believe that golf course operation, as a whole, does not pose immediate threat to the aquatic system.