

WATER QUALITY MONITORING AT QUEENSTOWN HARBOR

The results of five years of groundwater monitoring on a golf course located in an environmentally sensitive area.

by FRANK WM. "BILL" SHIRK



Bill Shirk, CGCS, takes care of Queenstown Harbor Golf Links, which is located in a critical area, defined as being within 1,000 feet of the Chesapeake Bay and its tributaries.

THE CONSTRUCTION of new golf courses today requires that a maze of environmental regulations be addressed. In areas where the construction and maintenance of golf courses potentially could affect surface waters or groundwater resources, water

quality monitoring often is required. Following is the story of the monitoring program at the Queenstown Harbor Golf Links.

The story of Queenstown Harbor starts at its location. The course is situated at the mouth of the Chester

River and the Little Queenstown Creek, less than a mile from the Chesapeake Bay. As such, it is designated as being in a *Critical Area* of Maryland's tidewater region. A *Critical Area* can be defined as a site that is within 1,000 feet of the Chesapeake

TABLE 1
Nitrate-Nitrogen Sampling Results at Queenstown Harbor Golf Links (results in mg/l)

Date	B-1	B-2	B-4	B-6	B-7	B-8	B-9	B-10	B-12	B-13	B-14	B-15	B-16	All Wells Average
11/15/90	0.02	0.13	6.10	0.02	14.00	19.00	2.60	0.83	no sample	no sample				5.34
03/20/91	0.03	1.60	8.51	0.04	8.18	17.40	4.36	8.24	no sample	0.05				5.38
05/20/91	0.03	2.90	7.90	0.04	7.50	15.00	6.50	8.90	6.80	0.52				5.61
09/30/91	0.02	0.02	no sample	0.05	8.62	19.00	4.81	1.83	0.41	0.08				3.87
04/06/92	0.33	1.80	7.60	0.05	4.20	10.00	8.30	11.00	0.40	0.05				4.37
06/23/92	0.23	2.90	8.10	0.03	8.40	23.00	8.30	16.00	0.15	0.06				6.72
10/05/92	0.35	1.70	7.70	0.01	7.70	21.00	7.10	3.00	0.10	0.03				4.87
01/12/93	0.03	1.40	11.00	0.13	9.60	21.00	10.20	9.20	0.51	0.02				6.31
03/31/93	0.15	2.10	1.90	0.09	5.30	18.30	6.30	12.10	0.20	0.30				4.67
06/23/93	0.08	2.00	3.40	0.05	7.90	12.70	3.50	23.00	0.05	1.80				5.45
10/06/93	0.07	1.70	5.00	0.86	7.30	8.30	2.40	4.00	0.05	1.30				3.10
01/17/94	0.05	1.40	4.30	0.05	3.30	16.40	1.90	12.50	0.19	2.10	6.50	10.00	1.50	4.63
04/05/94	0.10	1.60	3.50	0.10	1.90	12.50	1.30	5.20	no sample	0.80	18.30	9.50	4.00	4.90
06/20/94	0.30	2.10	4.50	0.40	2.90	11.20	1.20	5.40	0.40	0.80	10.70	7.20	3.20	3.87
10/06/94	0.40	1.40	4.90	0.20	2.00	14.90	0.70	6.10	0.30	1.30	6.60	4.40	2.40	3.51
Average	0.15	1.65	6.03	0.14	6.59	15.98	4.63	8.49	0.80	0.66	10.53	7.78	2.78	4.84

Bay and its tributaries. The concern is that improper management of *Critical Area* sites could impact the overall quality of the Bay waters. Thus, there was great concern about the development of a golf course near the environmentally sensitive Chesapeake Bay.

The property was owned and operated as a working farm for 25 years by Washington Brick and Terra Cotta Company. Prior to breaking ground on the construction of a 27-hole, upscale, public golf course, the approval process consisted of 7½ years of permitting and 43 public hearings. These hearings seemed to be forums for change regarding environmental laws and, more specifically, the interpretation of how to define and best preserve a wetland. Eventually, the Critical Area Commission and the Washington Brick and Terra Cotta Company agreed to the installation of groundwater monitoring stations throughout the property.

Thirteen monitoring wells were installed using a drilling rig with hollow-stem augers in July 1990. Installing the wells prior to construction provided a basis for data comparison. Concentration data were collected on nitrates, phosphates, and other materials within the water supply prior to converting the land to a golf course.

Finally, Washington Brick and Terra Cotta Company broke ground for their project on August 1, 1990. The golf course lies on a 750-acre tract of land that had been used primarily as farm-

land. Hardwood forest, non-tidal wetlands, and tidal wetlands present on the site were incorporated into the course layout. The course was opened for play in July 1991. An additional nine holes were built in 1994 to complete Queenstown Harbor Golf Links as a 36-hole, upscale, public access golf course.

Environmental Monitoring

The monitoring sites were a critical aspect of the golf course development project, and their locations were carefully determined according to subsurface water flow. The quality of subsurface water that enters the Chesapeake Bay has been and continues to be a major concern to people who inhabit the areas around the Bay. More specifically, the potential for nutrient loading has been a high-priority issue of many environmental groups and governmental agencies in this region of the country. With the implementation of the monitoring program, valuable documentation about the effects of turfgrass management practices on the environment could be collected and analyzed. Needless to say, there were many questions and a great deal of apprehension regarding the conversion of agricultural land to a golf course facility.

Analysis of the groundwater samples is performed by Apogee Research Inc. (an independent lab) of Bethesda, Maryland, four times per year. Steve Roy is in charge of this project. Their

reports are used to help me better manage and adjust our integrated pest management (IPM) program. For example, adjustments to fertilizer programs are facilitated by the monitoring results.

The agreement specified that the results of each sampling would be sent to the Critical Area Commission, Queen Anne's County Planning Department, Washington Brick and Terra Cotta Company, in addition to my office. The Critical Area Commission has received the monitoring data with the hope that it will help them decide about the future of golf course development in Critical Area zones of the Chesapeake Bay and its tributaries. For that matter, it is hoped that our experiences can help others in the development and proper management of a golf course in an environmentally sensitive area of the country.

On November 15, 1990, nine wells were tested for the first time. We now have nearly five years of data from the original monitoring wells. During construction, additional wells were installed. The first report and the last report will be highlighted in this discussion.

November 1990 Test Results

The Federal Drinking Water Purity Standard for nitrate-nitrogen is 10 mg/liter (10 ppm). Of the wells sampled, two samples (well B-7 and well B-8) revealed elevated nitrate levels of 14

mg/l and 19 mg/l, respectively, (see Table 1) on the first sampling date. These two wells are located at a groundwater discharge point to the Chester River and demonstrated the significant impact from the previous agricultural land use operations. Well B-4, located in what is now the practice fairway, exhibited a slightly higher nitrate level (6.1 mg/l) than the other monitoring wells. This specific area was also exposed to intense agricultural operations prior to conversion to golf course turf.

The average concentration of nitrate-nitrogen from the first sampling date for all the wells was 5.34 mg/l. Although average concentrations may not tell the complete story, the data provided a reference point. Well B-1 (.02 mg/l) represented what is considered to be background disturbance as water moves onto the site. Phosphorus levels for this well (.88 mg/l total phosphorus and 4.10 mg/l orthophosphate) were quite high. Again, these levels may be indicative of how agricultural land use can affect groundwater.

During the initial testing prior to any applications to the golf course, three wells (B-1, B-7, and B-10) showed contamination. The pesticides included: carbofuran (Furadan) and carbaryl (Sevin), commonly used agricultural insecticides; pendimethalin and atrazine, commonly used herbicides (pre-emergent); and the fungicides chlorothalonil and iprodione. All samples provided results below analytical detection levels. Nevertheless, trace activity was observed, which provided important reference data regarding the trends of



Wetlands and environmentally sensitive habitat areas are designated as protected areas throughout the entire golf course property.

Areas between the golf course and the Chesapeake Bay water were established as low-maintenance and naturalized buffer areas.



the water quality prior to and during construction, and after grassing the golf course (Table 2).

October 1994 Test Results

After nearly five years of testing, nitrate-nitrogen concentrations are the primary area of concern. Data collected on all other nutrients and pesticides have produced results that are classified as *analytically undetectable*. The fact that nutrient and pesticide concentrations in the groundwater supplies have dropped from their pre-golf course levels demonstrates that a well-managed golf course can protect and even enhance water quality compared to other common land uses. Groundwater samples continue to be analyzed for nitrate-nitrogen, primarily for two reasons:

1. to continue to monitor potential nutrient loading of the Chesapeake Bay, in particular nitrogen, and
2. to determine the usefulness of nitrate-nitrogen as an indicator of groundwater quality conditions and to study its movement.

The average nitrate-nitrogen concentration of all the wells has fallen since the testing program was implemented.

The average concentration from all wells decreased from the 5.34 mg/l determined in November 1990. This decrease represents a 35% drop in the average nitrate concentrations within the water across all the wells. Despite minor fluctuations that have occurred over time, the phosphate levels continue to drop, and one well, B-8, has had elevated nitrate-nitrogen concentrations above the drinking water standard (Table 1). This well is located next to an active farm. We speculate that since the implementation of the well water testing program, corn, soybeans, and wheat crops have been grown and harvested from the adjacent parcel, perhaps contributing to the elevated nitrate levels.

Wells that had previously been above 10 mg/l (B-7, B-14, B-15) have shown steady improvement, all dropping below the water purity standard. The testing at well sites B-14, B-15, and B-16 began in 1994. The land was aggressively farmed until the fall of 1993. This area was developed into an additional nine golf holes, and we believe the test results for these wells will show a decline in the nitrate levels similar to the other monitoring sites.

In August 1995, members of the Maryland Senate Economic and Environmental Affairs Committee toured Queenstown Harbor Golf Links. The tour provided an opportunity to demonstrate the technology being used to manage our golf course turf. Important information was provided for legislators that will help them make future decisions about golf course issues. More importantly, the legislators learned that integrated pest management programs that contain best management practices can be used to operate a golf course located in a critical area in a responsible manner.

It took a lot of effort and expense to get us to this point. The staff at the Queenstown Harbor Golf Links believe our efforts have contributed to a better understanding that properly maintained turfgrass can have a positive impact on the environment. Golfers, non-golfers, and the area's wildlife are co-existing nicely with the Chesapeake Bay and its tributaries.

BILL SHIRK, CGCS, is the golf course superintendent at Queenstown Harbor Golf Links, located in Queenstown, Maryland.

TABLE 2
Queenstown Harbor Golf Links — Water Quality Laboratory Report (Sampling Date: 11/15/90)

Sample ID	Chemical (mg/l)	Nitrate Nitrogen	Ammonia Nitrogen	Kjeldahl Nitrogen	Phosphorus (total)	Orthophosphate Phosphorus	Carbofuran (ppb)	Carbaryl (ppb)	Prowl (ppb)	Chlorothalonil (ppb)	Iprodione (ppb)	Atrazine (ppb)
B-1		0.02	0.90	9.80	0.88	4.10	< 2.00	< 2.00	< 2.00	< 0.05	< 0.10	< 2.00
B-2		0.13	1.10	12.00	0.05	< 0.01						
B-4		6.10	0.20	18.00	0.24	< 0.01						
B-7		14.00	0.60	0.60	0.52	< 0.01	< 2.00	< 2.00	< 2.00	< 0.05	< 0.10	< 2.00
B-6		0.02	< 0.10	< 0.10	0.20	< 0.01						
B-8		19.00	< 0.10	9.10	0.05	< 0.01						
B-9		2.60	0.10	3.70	0.02	< 0.01						
B-10		0.83	< 0.10	1.80	0.02	< 0.01	< 2.00	< 2.00	< 2.00	< 0.05	< 0.10	< 2.00
LQC-1 (Little Queenstown Creek)		0.46										
CR-B-7 (Chester River)		0.39										
Feet:	Depth to Bottom	Tape to Water	Water level on Tape	Depth to Water	Top Casing	Water Level						
B-1	17.00	7.00	1.09	5.91	17.28	11.37						
B-2	16.50	11.50	0.99	10.51	21.41	10.90						
B-4	16.00	13.00	0.94	12.06	20.30	8.24						
B-6	14.00	12.20	1.54	10.66	19.90	9.24						
B-7	16.00	9.00	1.38	7.62	8.69	1.07						
B-8	20.00	14.50	0.95	13.55	19.94	6.39						
B-9	20.00	10.50	0.45	10.05	21.53	11.48						
B-10	22.00	16.00	0.96	15.04	24.31	9.27						
B-12	16.50	11.00	0.58	10.42	22.85	12.43						