# Four golf resorts are reusing treated sewage for irrigation

The Waterloo Biofilter is similar to standard trickle filter technology but the filter medium is absorbent for retention time without multiple passes. Because of its specific physical properties, the system is overall aerobic but concomitant anaerobic activity results in no aerobic sludge production as in other aerobic systems. Hydraulic overloads can be handled without the filter medium plugging or backing up.

ClubLink golf clubs and resorts in Ontario are treating sewage wastewater to the highest degree and reusing the treated effluent in the golf course irrigation system. **Figure 1** is an aerial view of the Blue Springs golf club. The filter is housed in the circled garage-type building. Stringent effluent criteria were set to meet objectives of both the company and the government. Soil disposal of sewage was not an option due to lack of space, difficult soils, and regulatory requirements.

One of the challenges was to meet the stringent effluent criteria, especially for ammonium, when extremely strong wastewater and variable daily and hourly flows are to be expected. Another challenge was to test the use of alum addition in septic tanks in high flow systems, a process that was successfully tested by Ministry of Environment personnel on small systems.

### Treatment system design

The design is kept as simple as possible and includes exterior grease traps, septic tanks, a surge pump tank, filters above or below ground, effluent re-circulation to the septic tank for ammonium removal, alum addition for phosphorus removal, and ultraviolet disinfection. **Figure 2** shows the Waterloo tanks used at Blue Springs golf club. A custom SCADA unit is an important design component and is invaluable for troubleshooting. Disposal is by gravity or pump to the irrigation ponds. The systems are operational year round with lower and weaker flows during the winter, but with no change in operation, and no addition of carbon source or nutrients.

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*Figure 1. Aerial photograph of Blue Springs golf club showing attractive garage-type building (circled) housing the sewage treatment plant.*

Addition of liquid alum to the septic tank is controlled by linking the alum pump to a sewage pump going to the septic tank or to an effluent pump to disposal, something that approximates the flow through the system. The strength of the alum is correlated with the expected loading of phosphorus. Tests of filter effluent carried out for ultraviolet disinfection effectiveness showed that a strong UV unit can remove *E. coli* well below the required limits.

**Table 1** shows the influent values measured in the septic tanks before alum addition. Most of the parameters are on average higher than the design criteria, with stronger wastewater during the busy summer season. Close co-operation with company staff keeps wastewater strength as low as possible.

The design concentration of 40 mg/L TKN proved fairly accurate but did increase in the busy season, often to >100 mg/L TKN, and >98% nitrification would be needed to meet the effluent criteria (**Table 2**). As expected, the organic matter loading was twice the design of 250 mg/L cBOD, but re-circulation of the filter effluent back to the septic tank reduced organic matter to a level where thorough nitrification could take place.

### Treatment system results

**Table 2** shows the effluent values of the golf resorts year by year, along with the compliance requirements and the target values. Generally the systems improve with age, even when the wastewater increases in mass loading. High mass loading is critical in the start-up phase (typically one month) where nitrifiers have not established themselves properly, and nitrification can be im-

**Table 1. ClubLink golf club influent values (median values mg/L; to June 2001)**

| | | cBOD | TSS | TKN | TP |
|---|---|---|---|---|---|
| **Design** | | 250 | 250 | 40 | 10 |
| **RattleSnake Point** | **1999** | 471 | 263 | 58 | 13.1 |
| | **2000** | 379 | 208 | 58 | 6.1 |
| | **2001** | 52-1620* | 133 | 21 | 2.4 |
| **Blue Springs** | **1999** | 423 | 147 | 47 | 6.0 |
| | **2000** | 535 | 175 | 38 | 6.2 |
| | **2001** | 156 | 49 | 35 | 1.2 |
| **Kings Riding** | **2000** | 1010 | 277 | 74 | 8.5 |
| | **2001** | 327 | 114 | 37 | 2.7 |
| **Rocky Crest** | **2000** | 202/459** | 74/88 | 39/93 | 3.3/9.6 |
| | **2001** | 326/ - | 141/ - | 30/ - | 4.7/ - |

* range provided; **resort/clubhouse sewage separated

*Figure 2. Waterloo Biofilters housed in portable polyethylene tanks 2.4 m diameter by 2.4 m high with controlled air flow using corrosion-resistant fans, each suitable to treat 5000 L/d.*

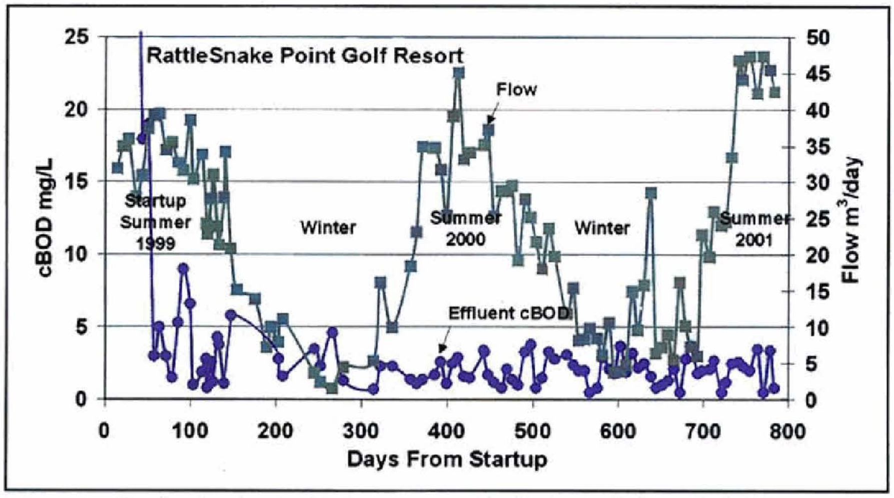


*Figure 3. Fluctuating hydraulic flow rates at RattleSnake Point golf club from season to season do not affect the quality of the filter effluent.*

peded by the high organic loading. Once the system has matured, above-design loadings can be handled without compromising the quality of effluent.

The filters react very favourably to flow fluctuations between busy and slack seasons, which in these cases are summer and winter, respectively. **Figure 3** shows the effluent cBOD values (left axis) compared to the actual daily flow rate measured (right axis) at RattleSnake Point golf club. The cBOD values are consistently <5 mg/L in both seasons, with flows ranging from <5 $m^3$ in the winter to over 45 $m^3$ in the summer. Ammonium values also remained consistently below target levels during periods of high and low flows. Both the alum addition and the UV disinfection performed very well, lowering the TP to <1 mg/L and *E. coli.* to 1 cfu/100 mL respectively.

The combination of high flows in the summer with high strength wastewater also led to above-design organic matter loadings. While this was not a problem during the second summer of operation, it can cause problems during the start-up period. Organic matter loading was well above design at Kings Riding right at start-up and inhibited adequate ammonium removal. To solve the problem quickly, more filter tanks were added, although ammonium values may have lowered on their own in time as the existing tanks matured.

**Acronyms**

| | |
|---|---|
| cBOD | - carbonaceous biochemical oxygen demand |
| TSS | - total suspended solids |
| TKN | - total Kjeldahl nitrogen |
| TP | - total phosphorous |
| BOD | - biochemical oxygen demand |
| $NH_4$-N | - ammonium nitrogen |
| TN | - total nitrogen |

The design to remove ammonium also has the effect of removing total nitrogen (TN = TKN+$NO_x$-N). TN values during the first year at three of the sites indicate removal rates of 60% in the buried concrete system where air is freely vented (RattleSnake) and 75% removal in the polyethylene containers where air supply is controlled (Blue Springs and Kings Riding).

In areas of very soft water, alkalinity concentrations are inadequate for nitrification to occur, and sodium bicarbonate added to the sewage successfully remediates this shortfall, although significantly adds to the maintenance requirements.

These surface discharge sites are all monitored remotely by a custom "Sitewatch" system that records temperatures, pump on and off times, flow rates, pressure switches, alarms, etc., and summarizes the data each day. Serious alarms are paged to the professional operator and to Waterloo Biofilter Systems Inc. Problem trouble-shooting is easy with the remote monitoring and data recording, and very difficult without it. Difficulties can be anticipated by daily inspection of the monitoring data, an example being the unbalanced cycling of pressure switches indicating the sticking of the rotating valve.

**Table 2. ClubLink golf club effluent values (median values mg/L; to June 2001)**

| | | cBOD | TSS | $NH_4$-N | TP | E.coli cfu/ 100mL | TN |
|---|---|---|---|---|---|---|---|
| **Compliance Target** | | 30<br>15 | 30<br>15 | 2.5<br>2.0 | 2.0-2.5<br>1.5-2.0 | 100<br>100 | n/a<br>n/a |
| **RattleSnake Point** | **1999** | 3.8 | 4.0 | 0.2 | 1.1 | 1 | 22.8 |
| | **2000** | 2.0 | 3.0 | 0.4 | 0.9 | <1 | 19.9 |
| | **2001** | 2.1 | 4.0 | 0.2 | 0.5 | 1 | - |
| **Blue Springs** | **1999** | 6.6 | 4.0 | 1.2 | 1.1 | 1 | 11.5 |
| | **2000** | 2.3 | 3.0 | 0.4 | 0.7 | 1 | 4.8 |
| | **2001** | 1.8 | 3.0 | 0.1 | 0.6 | 1 | - |
| **Kings Riding** | **2000** | 9.0 | 8.0 | 1.4 | 0.9 | 1 | 18.7 |
| | **2001** | 2.0 | 4.0 | <0.1 | 1.0 | 1 | - |
| **Rocky Crest** | **2000** | 5.0 | 3.0 | 1.7 | 0.5 | 1 | - |
| | **2001** | 3.0 | 5.0 | 0.2 | 0.2 | 1 | - |

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