

Waterloo Biofilter system repairs failed tile bed – saves replacement cost

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A Canadian summer camp revamps its onsite water treatment system.

by David C. Richardson

Canoeing, fishing, friends: These are the attractions of summer camp. For hundreds of children from the Toronto area, and throughout Canada, a one- or two-week stay at Pioneer Christian Camps would deliver. Each summer since 1929, young people have flocked to the campgrounds in the wilds of Ontario near Muskoka Lakes for fellowship, learning, and fun. Randy Roebuck, the director of operations for Pioneer Christian Camp, says Adventure Camp is one of three camping options offered on the 1,200-acre property. In the heart of lake country, the camp features “a whole lot of waterfront activities along with arts and crafts,” while high in the trees, rope and pulley courses provide young outdoor enthusiasts with an airborne test of will.

As staff prepared for Adventure Camp’s 2001 summer camping season, a fluid situation down in the trenches necessitated a different kind of test. In an area remote from the recreational activities, the camp’s tile bed drainage field was showing signs of trouble, and the condition had become critical.

The camp’s maintenance staff had noticed that they had to flush the lines with increased frequency. Additionally, according to Sandy Bos of Bos Engineering, the firm that was brought in to evaluate the situation, “The soils were plugging and failing due to the amount of organic matter passing through to it.”

Further, Bos says test holes dug in the field showed the “water was mounding right in the field itself. “We were just days away from breakout of the septic system,” he says. The problem had to be fixed quickly to avoid jeopardizing the safe and healthy operation of the campgrounds during the upcoming season.

Below the Surface

Craig Jowett, president of Waterloo Biofilter Systems, inspected the site in the spring of that year. He says there weren't many visitors staying on the grounds during that time, so he didn't expect to see high flows. Yet, he says, "The sewage was breaking out onto the surface of the bed."

Jowett brought in backhoes to remove the foot or two of cover over the pipes and get a better look at the situation. He was disturbed by what he found. "The bed was completely dry below the pipes." The water was not being absorbed into the sand as it should have been. He says, "It appeared that something had filled the voids in the sand and was blocking its porosity. The water was coming straight up into the ground."

This, Bos explains, was a terrible sign. "Once the soils get plugged it sets off a chain reaction; you get anaerobic bacteria growing, you get that black sludge within the bed, it plugs the sand off quickly, and it starts mounding effluent within the bed. And in no time at all the bed is basically done."

If the situation was not corrected quickly, sewage seeping out at the surface would result in a safety and health hazard for the camp or a potential violation of environmental regulations.

Class-Four System

Bos says the failing bed was part of what is categorized in Ontario as a Basic Class 4 system. According to Bos, its components included septic tanks piped to a fully raised leaching bed. Small-diameter piping fed the effluent to the bed. Because the camping facility had gradually outgrown its septic tank capacity, retention times in the tanks had become insufficient for settling out solids and degrading organics.

As a result, excess material was getting pushed straight through, with the effluent, to the tile bed. Bos says this corresponded with the observation that the piping had required flushing virtually every year to remove microbial growth within the pipe. But additionally, "There was arterial breakout from the system, and three-quarters of the tile bed wasn't getting used because the pipe itself kept getting plugged up."

According to Bos, the best solution involved replacing the existing system, "just ripping everything out and starting from scratch," all the while making sure to "be as frugal as possible."

Bedrock Country

"The Muskoka area is cottage country. It is also bedrock country," says Jowett. "There's not much soil, so a lot of the treatment has to be done on imported material, and this was the case at the Pioneer Camp."

In Jowett's opinion the cost of replacing the tile bed alone would be astronomical. The bed was massive, situated on the bedrock typical of the geology of the area. It incorporated between 8 and 10 feet in depth of imported sand, piled on the bedrock, and it encompassed an area of 100 feet by 150 feet at the top of a steep rise. Disposing of the existing sand and sludge and bringing in truckloads of fresh sand to this difficult site would involve a logistical nightmare. In retrospect, Jowett estimates the cost of replacement in the range of at least a half-million dollars.

However, Jowett says there was hope for the old sand. He theorized that introducing clean oxygenated effluent into the tile bed might revitalize the organisms living there. In this more vital environment, the

microbes would go to work digesting the sludge, in both the piping and the bed, bringing the tile bed back to health and functionality. “We didn’t really know why the sand was not accepting the water,” says Jowett. “But we decided we would try to fix it by treating the water first and sending the treated water to the raised bed, letting the bed serve as the disposal unit for the treated water.”

Bos liked the idea. “The bacteria in the sands would be able to basically cannibalize itself and clean itself up,” he says. Bos and Jowett put together a design that would reuse as much of the original system as possible, including the tile bed if it could be successfully rejuvenated. “We also realized the septic tanks were not large enough to handle the flows that came out of the facility,” Jowett adds.

“We increased that capacity by using the existing septic tanks as pump tanks. We followed the old lines up to the hill where we installed new septic tanks and added a new storage tank to handle the daily surges, from morning, lunch, and supper.” The surges could then be dosed “into our Biofilters over a 20-hour period to even out the flow.”

“We got approval fairly quickly through the Ontario Ministry of Environment,” says Bos. “Construction started virtually immediately.”

The renovations were carried out while the campground was in continuous operation, which Jowett says was a challenge with a workable solution. “We brought in a pump truck to empty the septic tanks and haul off the sewage. Meanwhile we continued to use the existing leaching beds.” When the new tanks were in place and the feeders were connected, the sewage was directed to the newly installed Waterloo treatment system.



Photo: Pioneer Christian Camp

Renovation occurred while the camp was in operation.

Twice the Average Flow

Roebuck says a total of 10 buildings, including lodges, showers, and kitchen facilities, were served by the raised bed system. During camping season, the various lodges and housing facilities accommodate 154 children and nearly 100 staff members. The entire complex generated very large sewage flows.

Jowett says a typical residential system would be designed to manage a peak flow equivalent to what would occur once every three days. However, he says, “For a camp with high flows for months on end we would design the system for twice the average flow.” Jowett says the objective is “to have that peak sit in the septic tank for three or four days,” in order to “facilitate good solid retention and fermentation reaction.” This would enable the Biofilters to treat heavy sewage dosed at high rates, “without getting a pileup of muck on top.”

System Components

According to Bos, who took charge of the design phase of the project, finding a treatment tank large enough to meet the requirements would be a challenge. In fact, Bos says, “They just don’t make tanks big enough for the kind of design flow that we were considering.”

Waterloo Biofilter Systems had developed treatment systems in several configurations including subsurface treatment tanks and tanks housed at grade in sheds. However, Bos says Waterloo Biofilter had been experimenting with a shipping container configuration to house its treatment process. He says the Adventure Camp renovation project presented “a perfect opportunity to go with that system.” It was the most economical from at least two perspectives; “it wouldn’t require building structure to house the Biofilter units, and it would avoid the expense of either purchasing or building new tanks to accommodate the filtration system.”



Photo: Pioneer Christian Camp

During construction a pump truck emptied sewage while the fully operational camp used the existing leaching beds.

Jowett says it would be one of the first applications of Waterloo’s shipping container configuration. “We used our 40 footer and our 20 footer together giving the system 60 cubic meters of flow per day.”

According to Jowett, the treatment units comprise of standard ISO containers, which have been customized into integrated Waterloo Biofilter Treatment systems. Each container is divided into two chambers: the treatment room and the control room. The treatment room houses the patented foam medium, the dosing system that comprises ceiling-mounted spray nozzles, and a drainage system. From the control room, operators can regulate the dosing and disposal pumps. Rheostat-controlled air fans can be used to ventilate the filter medium, and an optional space heater is offered as well.

The two units, which Jowett says required very minimal onsite assembly, were placed on gravel pads to be dosed from the septic tanks. Fifty percent of the treated effluent would be recycled into the septic tanks for a second stage of nitrate reduction, and the remainder would be sent to the treatment bed for disposal.

Jowett says the Biofilter medium was originally designed to have the reverse physical properties of sand. This would facilitate microbial attachment at the same rate as sand but would allow for heavier loadings. He explains that “the medium provides two things: habitat for microbes,” which he says can “colonize both the exterior and internal surfaces,” and “the open cells where the water comes through provides a food source.” The waste products, he says, are likewise taken away, and “those bubble up as gasses and water.” The treatment tanks are bulk filled with columns of growth medium comprising 2- to 3-inch polyethylene foam cubes.

A Cushy Life for Microbes

Jowett says the Waterloo Biofilter System’s foam cubes provide an advantage in comparison with trickle filters that use gravel or hard plastic bits as a growth medium. According to Jowett, when the biomat adhering to typical hard surface growth media builds up to “a certain thickness, it dies and sloughs off.” In a conventional system this material accumulates at the bottom of the treatment tank as sludge. By contrast the bacteria and microbes that colonize Waterloo’s sponge-like material are protected within the interior surfaces of the foam and can thrive there. “The water passes by them slowly, giving them time to eat up the contaminants, and they don’t produce sludge.”

Jowett says, “We realized that we actually had two environments.” On the outer surfaces of the foam, he says, an aerobic environment is the norm, while deep within the foam cubes an anaerobic environment prevails. “We discovered that by increasing the air flow through the system we would create a purely aerobic environment.” Under those conditions he says all of the activity would take place on the outside of the foam pieces producing clear effluent, “but with this dandruff in it. That was the aerobic sludge.” He says by turning down the fan and reducing airflow “we got clear effluent within hours, with no dandruff.” He says this means that the Biofilter system provides both aerobic and anaerobic treatment within the same treatment cycle providing huge reductions in sludge formation. In fact, Jowett says over the 15 years of operation with over 1,000 systems deployed, “We have never had to clean a system because of sludge formation.”

Winter Recovery

Though the peak operation of Pioneer Christian Camp occurs during the summer months, provisions were made for cold Canadian winters. Because the pipe runs are of considerable length, Jowett says small holes were provided for back flow to allow sewage to drain back toward the tank during periods of low flows, preventing freezing in winter. Though, Jowett says, “there is never any standing water in the Biofilter system, the foam itself never dries out.” This, he says, allows biological activity to continue throughout the winter, digesting residual sewage left over from high strength loadings during peak seasons. Jowett says ultimately the bacteria will scavenge on what little nutrient might be present “before going dormant.” In the moist environment, however, “they do not die but revive in the spring” when the flow resumes “and begin treating the effluent.”

Post Installation

To maintain the integrity of the new system, Jowett made several recommendations to ensure satisfactory results over the long term. In Jowett’s view, “It’s sort of a marriage between the technologies that go before and after the treatment. You have to have a septic tank that is hydraulically justified. Following that, the soil and sand for the drainage bed has to be the proper type.” And he believes the operation of the facility that generates the raw sewage must be considered as well. “It’s like you’ve got a nice car but you don’t put gasoline into it—you put in kerosene. It’s not gonna run very long, and right now a lot of people are putting kerosene into their systems in the form of disinfectants.”

After installing the system, Jowett toured the campground’s facilities to highlight areas of concern and make recommendations to ensure optimal performance of the new sewage treatment system. He says it was important to point out the need to prevent the overuse of disinfectant. For example, he demonstrated to kitchen staff that they could achieve the required level of sanitation by “washing surfaces with warm soapy water and then spraying on a residual coating of disinfectant.”

Bos says it is also important to manage flows. “The biggest thing at camps is that if you’ve got a leaky toilet it could go on leaking for days before anybody deals with it. So we got the staff to institute conservation measures, such as checking all washrooms regularly, to make sure there are no toilets running.” In addition, he says the urinals and toilets were upgraded to low-flush systems.

Almost Clean Water

After several years in operation, Jowett says, “The system is functioning very well.” He still reviews the data collected on effluent quality from the Biofilter. He says chemical biological oxygen demand (CBOD) and total suspended solids readings have consistently come in below 10 milligrams per liter. He says,

“The latest number from the middle of January 2007 is CBOD of 8 milligrams per liter and total suspended solids of 7 milligrams per liter, which is very high quality for a winter sampling. Anything below 10 is almost pure water.”



Photo: Pioneer Christian Camp

Despite summer being peak use time, Pioneer Christian Camp also prepared for the long and cold Canadian winter.

According to Bos, however, “The big concern we had was whether or not that bed was going to come back. It was failing badly. We were concerned that it wouldn’t be able to rejuvenate itself, that those soils were going to be blocked off and they weren’t going to be able to come back.”

But that cleaner oxygenated effluent from the Waterloo Biofilter has also been flowing through the tile bed. Bos says, as a result, “It rejuvenated itself, and we didn’t have to do anything to the tile bed. Craig Jowett was confident that those soils would rejuvenate, and he was correct. As a result of the addition of the Waterloo Biofilter units, we saved that bed.”

Camping Is Fun

Though they were situated not more than 60 yards from camper chalets, Roebuck says the shipping containers that house the Waterloo Biofilter Treatment System are completely unobtrusive. “They’re hidden behind a screen of trees of at least 75 feet,” and they share the high plateau comfortably, with the camp’s archery range.

Roebuck says, at the Pioneer Christian Camp “we try to keep the engineering part of it simple.” And he says, “Surprisingly, considering the level of technology involved, maintenance requirements have been minimal.” He says once every three days, a campground staff person visits the treatment facility to check the indicators and the equipment.

Roebuck says, “The dosing filters get checked on a monthly basis. “We have never had a problem where I’ve had to call in a technician.” The worry-free operation gives Roebuck and camp staff more time to make sure the kids have the best outdoor experience the Canadian countryside has to offer.

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