

# **SUSTAINABLE, LOW-MAINTENANCE DISINFECTION FOR ONSITE SYSTEMS**

Summary of the conference presented by Roger Lacasse  
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## SUSTAINABLE, LOW-MAINTENANCE DISINFECTION FOR ONSITE SYSTEMS

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Most of the regulations applicable for onsite wastewater treatment system are based on the use of native soil for effluent dispersal. However, there are more and more situations where dispersal of effluent in native soil is impossible; repairs of existing systems on undersized lots for implementation of required dispersal fields; sites located in soils having low permeability; or where the bedrock or groundwater level is near the surface. For most of these cases, the wastewater treatment solution must include a disinfection unit to assure health and safety protection. This is particularly important for sites where the treatment system is installed on imported soil over fractured bedrock allowing the possible direct discharge of treated effluent into the groundwater. Chlorination and UV light are currently the most common methods used for disinfection of wastewater. While these processes are generally well-adapted to community or municipal installations, their operation and maintenance needs present some limitations in order to ensure sustainable performance for individual home applications (ex: chlorine addition, cleaning of the quartz sleeve in UV systems, etc.). Management of such individual disinfection systems can be costly and, if neglected, may present risks to both human health and receiving water quality. In view of these limitations, a need remains for a low maintenance disinfection system suitable for individual home applications.

In 2003, Premier Tech Environment (PTE) started a research and development project to develop a passive disinfection approach meeting this need. We evaluated the concept of “sand mantle” prescribed in Ontario regulation and the horizontal sand filter approach used many years ago in France. Based on this evaluation, we designed a new concept of horizontal sand filter corresponding to an optimized version of the “sand mantle” but with a lower footprint. The passive disinfection system developed is essentially a horizontal sand filter (HSF), which is fed vertically by the advanced secondary effluent produced by the peat based Ecoflo<sup>®</sup> Biofilter. The biofilter effluent is evenly applied on the first section of the horizontal sand filter by a low pressure distribution system or by using an open bottom Ecoflo<sup>®</sup> Biofilter module. The HSF consists of a 30 cm layer of filtration sand ( $D_{10} = 0.15$  to  $0.5$ ,  $C_u = 3$  to  $4$ ) spanning over an impermeable liner with a length of 10 m and a slope of 3 to 5 %. The filter width is sized on a linear loading rate (LLR) of 225 L/m.d. The horizontal filter operates in aerobic conditions and air renewal is provided by interconnection of the gravel layer over sand with the Ecoflo<sup>®</sup> Biofilter aeration system. At the downstream extremity of the horizontal filter, a collection and sampling device is provided. The treated effluent is collected by a perforated pipe located in a gravel trench surrounded by geotextile and followed by a sampling port and a diffusion pipe for final dispersion.

The PTE horizontal sand filter (HSF) has been tested at full scale in two different sites. The first system (Site 1) was installed in September 2003 at the Ontario Rural Wastewater Centre (ORWC) located at Alfred campus of the University of Guelph. The experimental system consists of a 3,600 L septic tank followed by an Ecoflo<sup>®</sup> Biofilter ST-500 (open bottom module) and the new horizontal sand filter. For this test setup, the HSF (10 m long, 2,5 m

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wide) received treated effluent from one half of the biofilter and it has been tested at a linear loading rate up to 240 L/m.d. The second full scale system (Site 2) has been in operation since May 2005 at a single family dwelling located in Malartic (Abitibi) in the northern part of the province of Quebec (Canada). The system consists of a 3,200 L septic tank followed by an Ecoflo<sup>®</sup> Biofilter ST-650 (open bottom module) and the horizontal sand filter (5.5 m wide x 10 m long). The mean flow rate corresponds to 750 Lpd (LLR of 136 L/m.d).

The fecal coliform (FC) results obtained after 33 months of monitoring at Site 1 and 18 months at Site 2 are presented in Table 1. These results indicate that the combination of Ecoflo<sup>®</sup> Biofilter and horizontal sand filter reduced fecal coliform to near detection limit (< 10 counts/100 mL) with geometric average of 18 and 11 counts/100 mL for Site 1 and 2 respectively.

Table 1 Disinfection performance of combined Ecoflo<sup>®</sup> Biofilter and Horizontal Sand Filter

Site	Septic tank effluent (FC counts/100 mL)	HSF effluent (FC counts/100 mL)	Reduction (log)	Period of monitoring (months)
1	1.3x10 <sup>6</sup>	18 *	4.9	33
2	4.6x10 <sup>6</sup>	11 **	5.6	18

\* Geometric average of 95 samples.

\*\* Geometric average of 52 samples.

Noted that values that are less than detection limit were reported as the limit.

Furthermore, we note that the performance is very stable at the HSF outlet, counts varying at Site 1 from 10 to 390 counts/100 mL and only 6 of the 95 fecal results (6.3% of the results) exceeded 200 counts/100 mL, the standard criteria for surface discharge. At Site 2, the fecal coliform counts at the HSF effluent are also very stable with only 3 of the 52 values exceeding 200 counts/100 mL (5.8% of the results). It is important to note that the wastewater temperature at the two sites were particularly cold in winter with values of the septic tank effluent ranging from 1.2 and 5.5 °C in January and February at Site 1 and between 1.5°C to 5°C at Site 2. The disinfection performance was not significantly affected by cold wastewater temperature as presented in Table 2 below.

Table 2 Effect of temperature on fecal coliform results at Site 1 (LLR=180 L/m.d)

Sample Point	Geometric Average (counts/100mL)	P-value (P=0.05)
STE (15±5°C)	1.09 x 10 <sup>6</sup>	0.14
STE (4±2°C)	1.67 x 10 <sup>6</sup>	
HSF effluent (15±5°C)	1.42 x 10 <sup>1</sup>	0.60
HSF effluent (4±2°C)	1.70 x 10 <sup>1</sup>	

Examination of the horizontal filter after 30 months of testing at Site 1 revealed that the filtering sand was still in very good condition with no clogging mat formation. Based on these observations, we expect the horizontal sand filter to provide long-term performance with little maintenance.

Finally, at the two sites, the unique combination of the Ecoflo<sup>®</sup> Biofilter and the horizontal sand filter achieves complete or near complete removal of fecal coliform in all conditions tested including very cold wastewater temperature. There is no classification in the various existing regulations in Canada and United States for such a performance level and addition of a new performance class should be seriously considered to provide solutions for difficult sites and to protect environmentally sensitive areas. This performance is mainly related to the high quality effluent constantly produced by the Ecoflo<sup>®</sup> Biofilter located upstream of the horizontal sand filter and by the very good water and air circulation in the horizontal filter. The physical barrier provided by the Ecoflo<sup>®</sup>'s filtering media results in a stable performance even during peak flow conditions. This also prevents the application of peak loads in TSS and CBOD<sub>5</sub> on the horizontal sand filter which could reduce its life span. The use of this passive disinfection process with treatment systems not incorporating a physical barrier, such as fixed-film or other aerobic treatment units, is not recommended due to the effluent quality variations inherent to these systems during peak flow, particularly in conditions of discontinued flow rate (ex: seasonal cottages).