Development of ‘Whitby’ Sand Filter

The MOE tested Filter Beds using six different types of sand from 1969 to 1973 using sewage from the Whitby psychiatric hospital. Hence, this testing is referred to as the ‘Whitby’ sand Filter Bed testing (Chowdhry, 1974). This research was well ahead of its time in North America, perhaps by 15-20 years. One of the sands was mixed with ‘red mud’ for phosphorus removal. Only the other five clear sands tested at Whitby are of interest here, as they form the basis for the filter sands prescribed in OBC Sentence 8.7.5.3.(3).

The Whitby sand Filter Beds were constructed in boxes 3.05 m by 3.66 m in plan view and 0.76 m in depth. They were fed at rates of 24, 49, and 73 L/m^2/day by ‘trickle’ and ‘time-dosed’ flush flow through three 2.4-m lengths of 100 mm perforated pipes set 1.2 m apart within crushed stone. Under-drain pipes at the base of the 760-mm thick sand kept the filters free-draining, and collected the effluent for sampling before being discharged to a tile bed (Figure 1).

Figure 1. Schematic of Whitby Filter Beds as tested by Chowdhry (1974), with under-drain to keep the sand filter free-draining to ensure treatment.

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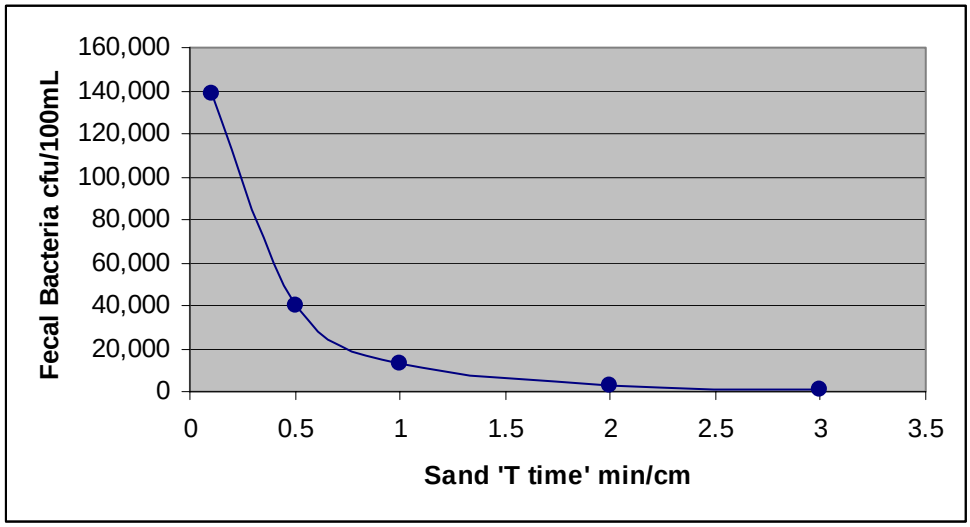
coarse, (b) finer grained sand, (c) biological

biomat clogging by septic tank effluent is greater. Extrapolating the line out to T = 6-10 min/cm sand predicts the thorough removal of fecals when dosing proprietary filter-treated effluent onto finer 'Area Bed' sand, described below.

Figure 2. Average of fecal coliform median values expected at the 760 mm level of under-drained Filter Beds 6, 5, 3, 2, and 4 loaded at 73 L/m^2/day (excluding all 49 L/m^2/day results) with respect to percolation rates allowed in OBC Sentence 8.7.5.3.(3) (from Chowdhry, 1974). The average of Sands 6, 5, 3, and 4 that better represent the range of sands allowed in the OBC is about 44,000 cfu/100mL or ~40,000 for all five samples dosed at 73 L/m^2/day in Periods III and IV (see text).



sand Filter Bed were installed on coarse soil of perhaps T<10 min/cm (or on fractured bedrock). If ‘unsaturated’ and ‘under-drains’ are mentioned for a purpose, then it is reasonable to assume that the Filter Bed would best perform its treatment function when installed only in or on soils that are highly permeable.

Figure 3. Raised Filter Beds are installed in high-risk areas such as high water table and fractured bedrock without under-drains. Under the OBC, only 150 mm of fast, coarse sand may separate the bottom of the sand Filter Bed (which yields 40,000-44,000 fecals or more) from the groundwater resource.

Talbot *et al.*, 1998). The filters in question are dosed by uniform distribution means, and, very importantly, installed with a gravel under-drain to maintain free-draining conditions.

Figure 4. In this type of system, proprietary filter technology and specifically engineered, sized and oriented Area Beds work together to perform distinct treatment and disposal functions. The filter-treatment component is under-drained and contains sampling points to confirm filter-treatment. The disposal component of the system is comprised of a thin

difficult areas where raised beds are otherwise required. Additional infiltration area is provided by adjacent permeable topsoil.

Independent testing agencies have found that vertical movement of filtered effluent emanating from the Waterloo and Ecoflo filters through gravel and then 250 mm of the finer sand removes fecals to below detectable even at the much higher loading rates of 106 and 212 L/m^2/day (Heufelder, 2003; Jowett and Masuy, 2006). These tested loaded rates are much higher than the 75 L/m^2/day under the gravel in Area Beds and in OBC sand Filter Beds. Essentially non-detectable (<30 cfu/100mL) levels were also found after 10 m lateral movement through the finer sand at linear loading rates of ≥180 L/m/day (Alfred, 2005), again, similar to Area Beds and OBC Filter Beds when all treated water is directed one way. So these tests equal or exceed actual field conditions in Ontario for the proprietary absorbent filter systems as installed with shallow Area Beds.

Table 2 summarizes fecal fates in high-risk installations where vertical movement predominates, indicating that proprietary Area Beds can be expected to provide a more predictable and safer method of sewage treatment and disposal than the presently implemented OBC Filter Beds.

Table 2. Comparison of filter treatment technologies in Ontario, with most probable number of fecals at the base, the vertical separation to groundwater, sand or soil type below filter, and the estimated fecals entering the natural environment such as groundwater table ('GW').

After 12 years of experience in Ontario and elsewhere, there are many thousands of Area Beds installed on difficult sites, where sewage is first treated by underdrained absorbent media filtration, and then by fine sand filtration before it enters the natural environment. On-going management is in place, and treatment can be verified before problems from excessive disinfectant use, for instance, become irreversible.

With verifiable filter treatment of sewage, shallow disposal and on-going management, the Ecoflo and Waterloo systems constitute 'sustainable infrastructure' (Rubin *et al*., 2004) equivalent to managed municipal sewage treatment plants. In comparison, OBC Filter Beds are often installed differently than tested, and have no management. They are presumed compliant by prescription, but as yet cannot be considered sustainable infrastructure.

Conclusions

The performance of installed OBC sand Filter Beds can be estimated from the original MOE test results and provides a minimum standard of safety against which other filter systems may be measured. This analysis demonstrates that fecal removal in the OBC sand Filter Beds is very good overall, but is optimum when; (a) using the finer-grained sands 2, 3, & 4 (percolation of 1-3 min/cm), (b) using a loading rate of 50 $L/m^2/day$, and (c) installed in free-draining sandy soils (*e.g.*, T<10 min/cm). It is reasonable to suggest that these construction criteria be used when installing Filter Beds.

Independent field testing shows that proprietary Ecoflo and Waterloo Area Bed systems go beyond what is expected in fecal removal, exceeding the performance of OBC sand Filter Beds, and improving on the quality of effluent entering the natural environment. With robust, low-energy filter treatment and on-going management, these systems exemplify a new 'on-site sustainable infrastructure' that is equivalent to centralized municipal sewage treatment plants.

References

Alfred College, 2005. Evaluation of fecal coliform attenuation in an Ecoflo Biofilter, University of Guelph, 30 p.

Chowdhry, N.A., 1974. Domestic sewage treatment by under-drained filter systems. Publication No. 53, Applied Science Section, Ministry of the Environment, Toronto, 93 p.

Costa, J., 2001. Waterloo Biofilter® Technology Fact Sheet – Interim Findings. Massachusetts Alternative Septic System Test Center. Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Buzzards Bay Project, East Wareham, 2 p.

Crites, R. and Tchobanoglous, G., 1998. Small and Decentralized Wastewater Management Systems. Boston, MA, McGraw-Hill, 1084 p.

Heufelder, G., 2003. Buzzards Bay Waterloo test and pan lysimeter results. Barnstable County Department of Health and Environment Report, 3 p.

Jowett, E.C. and McMaster, M.L., 1995. On-site wastewater treatment using unsaturated absorbent biofilters. Journal of Environmental Quality, v. 24, p. 86-95.

Jowett, E.C. and Masuy, P., 2006. Safe in-ground disposal of treated sewage. Environmental Science & Engineering, v. 19, January, 2006 (in press).

Mokma, D.L., Loudon, T.L. and Miller, P., 2001. Rationale for shallow trenches in soil treatment systems. In, Proceedings, ASAE Ninth National Symposium on Individual and Small Community Sewage Systems, Fort Worth TX, p. 71-79.