SEPTIC TANK OUTLET FILTERS

D J Stafford and J H Whitehead
University of Newcastle, Callaghan, NSW 2300

Abstract

The performance of post-primary treatment components of on-site wastewater management systems is critically dependent on the loads imposed upon them, in particular those of biochemical oxygen demand (BOD_5) and total suspended solids (TSS). A potentially cost effective means of reducing solids carry-over and improving the quality of treated wastewater is by the fitting or retrofitting of a septic tank outlet filter. Currently, the fitting of septic tank outlet filters is not mandatory in many jurisdictions in Australia, but there is compelling evidence from both the USA and New Zealand that significant performance improvements can be gained by fitting such filters and that the service life of the components of the treatment system which follow can be considerably extended.

This paper reviews the variety of septic tank outlet filters available in Australia and New Zealand, describes their design, construction, installation and performance expectations.

Keywords

Performance, post-primary treatment, screens, septic tank outlet filters.

1 Introduction

It is commonly considered that the performance of the post-primary treatment components of on-site wastewater management systems – including sand and media filters, disinfection systems, mounds, absorption trenches and irrigation areas – is critically dependent on the loads imposed upon them, in particular those of biochemical oxygen demand (BOD) and total suspended solids (TSS). In the United States, where in excess of 26 million premises are served by on-site wastewater management systems (USEPA, 2000), it has become increasingly common practice to incorporate septic tank outlet filters to enhance system performance. Septic tank outlet filters are installed in the outlet tee of a septic tank and may be installed in new systems or retrofitted to existing systems. They can effectively reduce the discharge of gross solids (Crites and Tchobanoglous, 1998) and various claims are made, particularly by some manufacturers, that septic tank outlet filters are effective in reducing BOD_5, TSS and fats, oils and greases (FOG) (Lowhorn, 1999, Zabel, 1999).

The Design Loading Rates for soil-based land application systems (trenches and beds) presented in AS/NZS 1547:2000 “On-site domestic wastewater management” (Standards Australia, 2000) recognise the critical dependence of such land application systems on effluent quality, particularly in terms of BOD_5 and TSS. Table 4.2A1 recommends lower Design Loading Rates for Primary-treated effluent than for Secondary-treated effluent where effluent quality is equal to or better than 20 g/m^3 BOD_5 and 30 g/m^3 TSS. Where other components of a treatment and land application system are installed following a septic tank, for example sand and media filters, disinfection systems, mounds and irrigation areas, their performance is also dependent on the BOD and TSS loads.

Although both disk filters (as a replacement for an outlet tee on a modified single compartment septic tank) and screen vault septic tanks incorporating polyethylene mesh

screens were mentioned in the 1994 second edition of New Zealand manual TP58 (ARC Environment, 1994), they were considered then as emerging technologies. Prior to some very recent revisions, Australian state guidelines have provided no mention of, or guidance on, septic tank outlet filters. In the current Standard AS/NZS 1547:2000, outlet filters are considered elements of alternative systems (Part 3A4.3), to be inspected and cleaned (if fitted) (Part 3A5.2(a)(v)), or as modifications to conventional systems (Part 4.3.5.1 Comment (a)).

A growing body of evidence from the United States (USEPA, 2000) has attested to the ability of septic tank outlet filters to enhance effluent treatment by removal of gross solids, and thereby both protect and increase the performance life of post primary treatment elements of on-site wastewater systems. Consequently, they have become increasingly required by regulators there and have been adopted in ever growing numbers. A wide range of septic tank outlet filters, of varying designs, materials and sizes is currently available in the US market.

There has, however, been relatively little published about the quantifiable performance benefits of such outlet filters and, it would seem, few studies undertaken to monitor and assess performance. One such study (Byers *et al.*, 2001) confirmed the ability of septic tank outlet filters to consistently and predictably prevent gross solids from leaving the septic tank. It also demonstrated great variability in the effectiveness of the filters to reduce TSS and BOD, a finite capacity to retain FOG and range of complex relationships between effluent characteristics and outlet filter maintenance requirements.

In Australia and New Zealand there has been a steady increase in the take-up of septic tank outlet filters. Local government regulators encourage or require their adoption and state and regional guidelines, as they are progressively revised and rewritten, specify them as relatively low cost additions to both new and existing systems. The recent revision of TP58 (ARC, 2004), for example, considers septic tank outlet filters as ‘the norm’ and requires them in all single stage, two stage or multi-chamber tanks.

The recent meeting convened by Standards New Zealand to scope the need for and direction of a review of AS/NZS 1547:2000, and the related AS/NZS 1546 product standards, has raised amongst technical issues for consideration, that effluent outlet filters in septic tanks become standard fittings (On-site NewZ, 2005).

2 Purposes of outlet filters

Promotional material from manufacturers of septic tank outlet filters make a number of claims for them. Clogging of lateral fields, the primary reason for the failure of septic systems, is prevented by fitting an outlet filter (Zoeller); they prolong the life of drain-fields (e-cogent) and trenches and prevent outlet blockages (Everhard); by preventing the flushing out of solids, and hence desirable micro-organisms, during high inflows and by the gas bubbles generated during anaerobic digestion, efficiency can be enhanced and the period between pump out of the septic tank extended (OSI). Some claim proven reductions of TSS to less than 30mg/l or about 2.5 times less than found in non-screened effluent (OSI), others a 40% reduction in TSS (Zabel). No claims are made for significant BOD reductions although some manufacturers refer to the enhancement of filtration due to biomass build-up on the filters and the reduction of particulate BOD.

Byers *et al.* (2001) noted variable performance of outlet filters. They also noted that by retaining gross solids, outlet filters provided important protection for downstream components and useful enhancement of primary treatment. In addition, they warned owners of adverse perturbations in their system.

At the very least, filters prevent gross solids from leaving the tank ensuring more complete digestion and thus protecting and prolonging the life of flow splitters, sand filters, drain-fields and other system components. They are essential in dosing systems to ensure the efficient operation of submersible pumps or automatic siphons located immediately downstream of the septic tank.

3 Availability of outlet filters in Australia and New Zealand

A number of septic tank outlet filters are available in Australia and New Zealand (Table 1). These vary in claimed purpose and performance, physical characteristics, construction, durability, filter mechanism and screen size, flow buffering, flow resistance, suitability for fitting to new and existing septic systems, ease of installation, cleaning, availability and cost.

Table 1 Septic tank outlet filters available in Australia and New Zealand

Manufacturer Filter	Type	Nominal diameter (mm)	Made in	Sourced from	Price June 2005
Bio-Microbics SaniTEE 1.6 mm	screen	100	USA	NZ	AUD $175.00
Bio-Microbics SaniTEE 3.15 mm	screen	100	USA	NZ	AUD $175.00
e-cogent EcoTube	screen	100	NZ	NZ	NZ $125.00
Everhard XtraTreat	screen	100	Australia	Australia	AUD $50.60
Gould GT150	disc	150	NZ	NZ	NZ $195.00
Gould GT500	disc	150	NZ	NZ	NZ $340.00
OSI FTi Biotube	screen	100	USA	Australia NZ	AUD $103.40
OSI FT Biotube	screen	100	USA	Australia NZ	AUD $136.40
Taylex	screen	100	Australia	Australia	AUD $58.00
Zabel A1800	screen	100	USA	USA	US $29.00
Zoeller WW	screen	100	USA	Australia NZ	AUD $170.00

4 Screen Characteristics

In the absence of agreed methods of testing septic tank outlet filters (Byers *et al.*, 2001), screen characteristics related to opening sizes and surface area have been tabulated. This information will allow informed conclusions to be made on the effectiveness of the screens in reducing suspended solids, particularly gross solids, the likelihood and frequency of clogging, ease of cleaning and the capacity for build up of biofilm that might reduce BOD.

Table 2 Opening and surface area characteristics

Manufacturer / Filter	Number of passes through screen see note 1	Area of smallest typical screen opening mm^2 see note 2	Smallest dimension of opening mm see note 3	Surface area mm^2 see note 4
Bio Microbics SaniTEE 1.6 mm	Not tested			
Bio Microbics SaniTEE 3.15 mm	1*	16.5	3	
e-cogent EcoTube	2*	12	3.2	
Everhard XtraTreat	1	10.5	3	6286
Gould GT 150	Not tested			
Gould GT 500	Not tested			
OSI FTi Biotube	1	10	3.2	4017
OSI FT Biotube	2#*	10	3	
Taylex	2#	13.4	2	2110
Zabel A1800	Not tested			
Zoeller WW	2	2.4	1.25	4876

Notes

1 filters marked # have a coarse first screen that is included in the number of passes
filters marked * discharge via a weir or keyhole surge moderation device that is not included in the number of passes as they are coarser than the screen through which the effluent has already passed

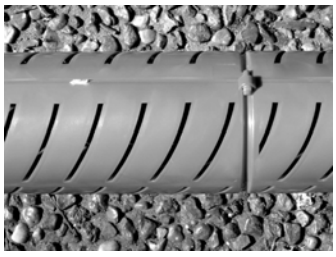
2 nominal average area

3 nominal average dimension

4 total wetted surface area from bottom of filter to a level 10mm above the outlet invert with filter installed to manufacturers recommendation

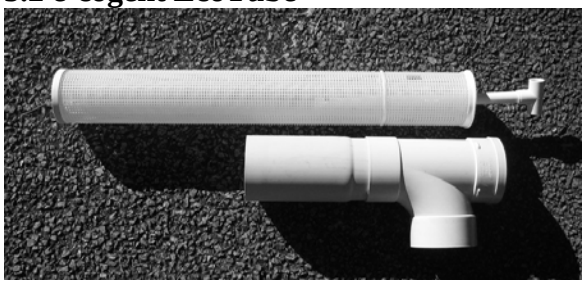
5 Construction, durability and use of outlet filters

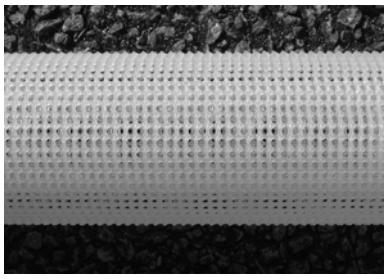
5.1 Bio-Microbics SaniTEE



The SaniTEE, manufactured by Bio-Microbics Inc., is a single long tube that is diagonally slotted to screen solids in a single pass prior to exiting through keyhole surge moderation slots at the outlet tee. The tube penetrates deep into the septic tank such that where the depth from bottom of tank to outlet invert is 1350 mm (e.g. Rutherford Concrete Products Pty Ltd 4500 litre septic tank), the bottom of the filter would be 490 mm clear of the bottom of the tank. Thus servicing of the tank before sludge builds up to this level becomes important. The SaniTEE filter is fitted with a plunger and washer that can be used in-situ to swab the inside of the filter. The whole unit is easily retrofitted to standard septic tank outlet junctions, provided the outlet is precisely located under the inspection opening. The tube is made in two longitudinal halves and is reasonably robust in construction. Only the 3.15 mm filter was tested.

5.2 e-cogent EcoTube

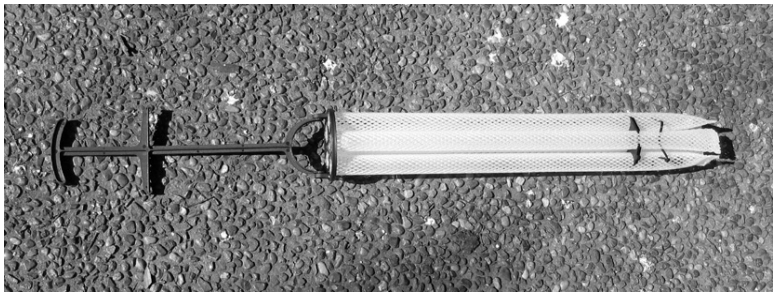


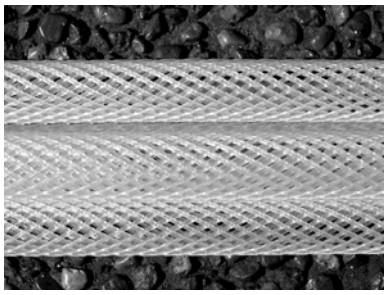


The EcoTube is constructed with two concentric polypropylene mesh screens. Stainless steel self tapping screws fix a top plate to the screens and a handle made of standard PVC pressure pipe slides through the plate within the inner mesh screen tube. It is supplied with or without an outlet junction. It is robustly made with few joints, thus improving its durability. As supplied, the EcoTube insert filter did not fit into the standard Everhard plastic outlet tee. Retrofitting would require a septic tank pump-out to enable a new outlet to be installed.

Effluent must pass through the screen twice and then via a plate fixed in the outlet with a low flow orifice for surge buffeting and a weir to accommodate peak flows. The concentric screens penetrate deeply into the septic tank, offering a large area of screen per litre of effluent to pass through - so cleaning intervals should be widely spaced. The open bottom of the filter may permit solids such as tampons, cigarette butts and gas-entrained solids to float up and clog the inner screen which may cause the filter to float above its intended location in the outlet junction. This would not prevent the filter from working and might even be advantageous if it educated users to be disciplined in what they flushed down the toilet.

5.3 Everhard Xtra Treat





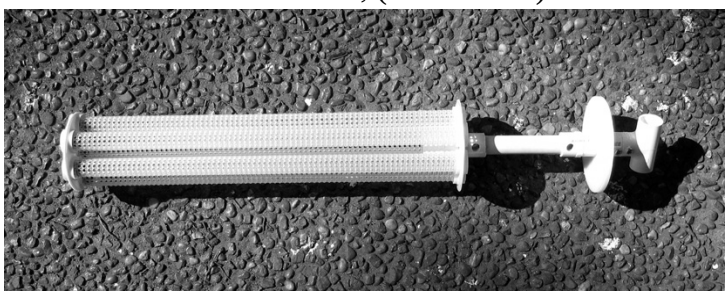
The Everhard XtraTreat filter is made of six polypropylene mesh tubes bundled together at the top by an injection moulded plate and handle assembly and at the bottom by an injection moulded fitting and zip-ties. Construction is robust apart from the handle that is none the less able to take typical handling. It is simple to insert in the outlet junction of most plastic and concrete tanks. Effluent passes once through the screen tubes. There is no surge-buffeting device. It is possible that solids such as tampons, cigarette butts and gas-entrained solids could float up and clog the spaces between the screen tubes and also float the filter. This could compromise the operation of the filter, especially if the filter floated up to a point where the top plate was above the invert of the outlet junction. In this case effluent could pass out of the septic tank without passing through the filter screens, although some very coarse filtration would still occur between the tubes and the wall of the outlet junction. To help resist floatation, glass marbles are inserted at the base of each of the six tubes.

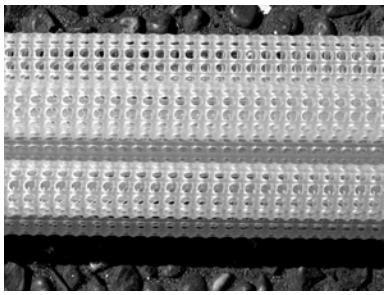
5.4 Gould GT 150 and 500 (two models)

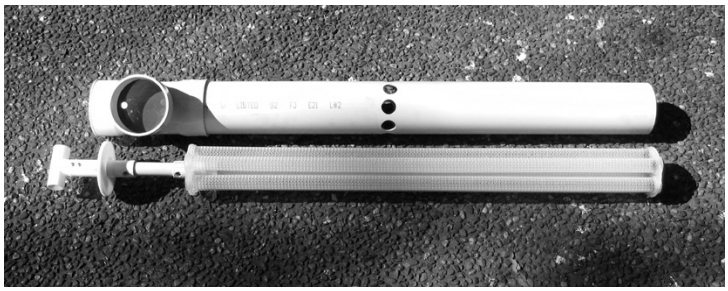
Rather than using mesh or slotted screens, the Gould filters employ spaced discs that collectively have a very large surface area. Effluent passes from one side of an outer cassette, through a stack of disks, to the outlet side. Vertical ribs in the cassette prevent short-circuiting. The filters are robustly made but do not suit standard Australian septic tank outlets, necessitating considerable modification to inspection covers and outlet tees. A Gould GT 150

has been in service in the author's system (Geary *et al*. 2003, figures 28 and 30) for several years. It performs well provided it is cleaned regularly. If left unmaintained for 12 months, pressure washing is required to clean the severely blocked spaces between the discs.

5.6 OSI FT Series Biotube, (two models)

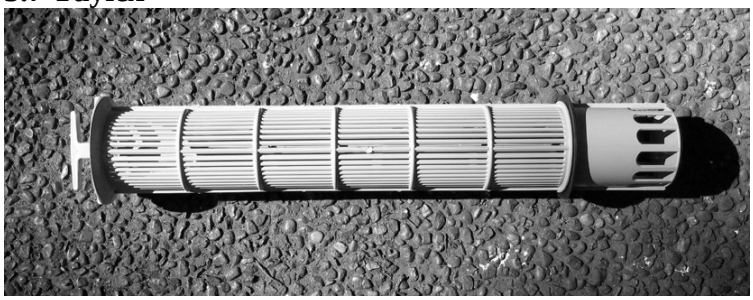






Orenco Systems Inc. manufacture a range of filters in the FT Series – a long filter complete with cassette that penetrates deep into the septic tank, a similar but shorter version and the FTi Series Biotube filter insert. To retrofit, the FT Series filters would require a septic tank pump-out to enable a new outlet to be installed. The FTi Series filter inserts can be easily retrofitted to most standard septic tanks without modification. The insert is constructed similarly to the Everhard XtraTreat but with seven tubes of slightly smaller diameter. The bottom of the filter is finished with a moulded plate in a slightly more robust design than the Everhard zip tie arrangement. The design at the bottom of the filter would also be less susceptible to entrapment of floating agents. The top of the filter tubes are held in a flanged plate that provides a good seal at the outlet, preventing unfiltered effluent escaping. It also provides a means of holding the filter in its correct location. A handle made of uPVC tubing with a tight fitting disk, precisely locates the filter relative to the outlet. Effluent passes the screens once prior to reaching the outlet, where optional surge baffle plates can be installed.

5.7 Taylex



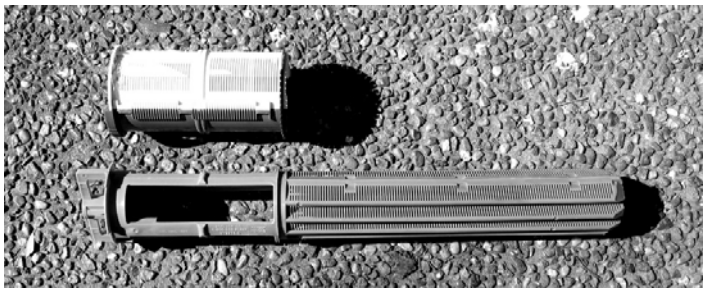
The Taylex filter is a single tube, double pass screen. Effluent enters the side of the tube through coarse slots, avoiding entrapment of floating matter, then passes out of the tube via a large area of finer slots. Being open at the top, it is unlikely that gas could build up and cause the filter to float. Manufactured in two halves, it is simple and reasonably robust in construction. A flange at the top of the tube accurately locates the filter in the outlet junction. Between the coarse slots and the finer screen, a rubber washer seal is provided that also helps hold the filter in place. This seal has been observed to dislodge upon removal of the filter from the outlet tee, however, this could be easily remedied by slightly serrating the outer edge

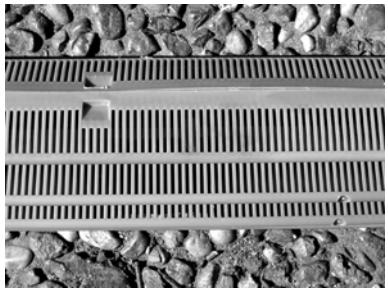
of the seal without compromising its performance. The filter is intended to be simply inserted into standard outlets in new or existing septic tank installations. There are no surge buffering provisions.

5.8 Zabel

The Zabel A1800 series is available in a number of variations, but in principle is very similar to the Taylex filter. The Zabel filters were not available for testing.

5.9 Zoeller WW





The "WW" in the title of the Zoeller filter is a reference to its complex folded shape intended to maximise the filtration area. The design is considerably more complex than any of the other reviewed filters, but it is easily fitted to new or existing installations. It has a sleeve that is inserted into the upper section of the outlet tee, held in place by a tab. The filter fits into the sleeve and is locked into position by rotating it under half flanges against a stop. The purpose of the sleeve is to prevent solids leaving the tank during removal of the filter for cleaning, although the sleeve must also be removed for cleaning once the filter has been cleaned. To do this, the cleaned filter must be reinserted into the sleeve to enable the sleeve to be withdrawn for cleaning inside and out. The filter is reasonably robust despite its complicated construction but it did not take any effort to accidentally break the locking tab off the sleeve. Effluent passes through the fine slotted screens twice but no surge dampening is provided. However, surge dampening might occur due to the increased flow resistance observed as flow rates increased. It appears possible that floating matter could build up in the cavity between the outlet junction and the w-shaped walls of the filter and that clogging of the fine screen slots would occur more readily than in other designs.

6 Flow resistance

While outlet filters can offer some surge dampening and thus prevent scouring and the escape of gross solids, it is important that they do not adversely dam the septic tank outlets. To provide an indicative measure of flow resistance of the filters, a standard outlet tee (Everhard plastic) was mounted in a 590 mm diameter tank. Once a steady state was reached, the head above the outlet invert was measured at flows of 5, 15 and 25 litres per minute. Filters were then inserted in the outlet and the head above the invert was similarly measured. The difference between the head before and after the filters were inserted was then calculated (Table 3).

Table 3 Indicative flow resistance of outlet filters

Manufacturer/Filter	mm head at 5 Lm^{-1}	mm head at 15 Lm^{-1}	mm head at 25 Lm^{-1}
Everhard XtraTreat	<3	<3	<3
OSI FTi Biotube	<3	<3	<3
Taylex	<3	<3	<3
Zoeller WW	<3	10	19

For each of the filters tested at 5 litres per minute the head above the outlet was less than 3 mm, and this remained the same for flows of 15 and 25 litres per minute for each of the filters apart from the Zoeller WW, for which the head above the outlet filter was 10 mm and 19 mm. Of the filters tested, the Zoeller WW has the smallest typical screen opening at 2.4mm^2 and the smallest opening at 1.25 mm (Table 2) and it is likely that these aspects of screen geometry have a significant impact on head above the invert. Whilst surge dampening might occur due to increased flow resistance, it is important to take this into account in septic tank configuration and sizing as significant increases in head are potentially problematic.

7 Conclusions

Septic tank outlet filters retain gross solids and thereby enhance digestion and filtration. They protect the downstream components of wastewater management systems from gross solids and associated blockages and thus prolong the life of those components. Most critically, outlet filters reduce TSS and BOD which are known to be the key factors in clogging soil-based absorption systems and resultant hydraulic failure. Septic tank outlet filters provide a warning as to when maintenance of the system is required and involve system users and owners in the oversight and maintenance of their systems. There is a need for long term research to ascertain more clearly the required cleaning and maintenance frequencies.

For domestic outlet filters, no quantifiable claims are made for BOD removal but some case studies make claims for percentage or proportional TSS removal. There remains an opportunity for further studies to more accurately quantify filter performance. Similarly, further studies in the quantification of flow resistance of "mature" filters at various stages of clogging prior to cleaning would be useful.

8 References

ARC, 2004. TP58 On-site Wastewater Systems: Design and Management Manual, Auckland Regional Council Technical Publication No. 58. Third Edition.

ARC Environment, 1994. TP58 On-site Wastewater Disposal from Households and Institutions, ARC Environment Technical Publication No. 58. Second Edition.

Byers, M.E., Zoeller, K.E. and Fletcher, J.D., 2001. Septic Tank Effluent Filters: Monitoring and Assessment, in Mancl, K. (ed.), On-site Wastewater Treatment, Proceedings of the Ninth National Symposium on Individual and Small Community Sewage Systems, Forth Worth, Texas, American Society of Agricultural Engineers, St. Joseph, Michigan. March 2001.

Crites, R. and Tchobanoglous, G., 1998. Small and Decentralised Wastewater Management Systems. WCB/McGraw-Hill Publishers.

Geary, P.M., Stafford, D., and Spinks, A.T., 2003, Performance Monitoring of a Low Cost Alternative On-site Effluent Treatment System, http://www.dlg.nsw.gov.au/dlg/dlghome/dlg_InformationIndex.asp?areaindex=SEPTIC&index=156 NSW Department of Local Government Septic Safe Research Grant Project R13.

Lowhorn, R. 1999. Managing Grease Through Filtration, Zabel Zone. Fall Ed. p54.

On-Site NewZ, 2005. Issue 05/2 On-Site NewZ, Auckland, New Zealand, April 2005.

Standards Australia, 2000. AS/NZS 1547:2000, On-site Domestic Wastewater Management, Standards Australia, Strathfield, NSW.

USEPA, 2000. Onsite Wastewater Treatment Systems Manual, United States Environmental Protection Agency, Cincinnati.

Zabel Zone. 1999. Zabel Filter Test Reports. Zabel Zone. Fall Ed. p63.