OPERATION, LIMITATIONS, AND RECOVERY OF SAND FILTERS

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This is a report based upon the findings of a study preformed in King County, WA. State, in 1999, that reviewed the operation and performance of alternative on-site systems. The purpose of this report is to make available facts that may be of importance to the on-site industry.

Part I Evaluation – Table I

Of the twenty-nine sites studied in the Part I phase of this study, twenty-one sites were found to be operating without ponding or surfacing. In Table 1, column 2, you will see that the average age of the twenty-one sites is 3.5 years, the oldest site being 6 years old.

The third column reflects the use of time controllers. Each site should have had time controllers installed. The number "1" indicates that a timer, approved for use in an on-site system, was installed and set properly. Out of twenty-one sites 10 sites had the correct timers and the correct settings. Four sites had no time controllers and were working as a demand system. These sites are marked with a "0". The remaining 7 sites had time controllers that were not approved for on-site system use and are inconsistent, one approved timer had been turned to manual by the owner, and the remaining timers were approved but set to operate in a demand mode. This is accomplished by reversing the values. As an example, a system that by code must cycle 4 times within 24 hours, if

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set 6 hours on instead of 6 hours off, will work as a demand system controlled by the floats. These sites are marked with an "1 /".

The fourth column shows whether or not the sand collected at each site met the specifications for C-33 sand. Sites where the sand did not meet the specifications are marked with an "X". All eleven of the twenty-one sites where the sand failed the C-33 test, had sand that failed in the 100 and 200 sieves with a higher percentage passing through than was allowed, or more retained in the pan under the 200 sieve. This does not indicate however, that at the time of installation, the sand would not have met the specifications. In the mid 1990s the sieve testing method to determine C-33 sand changed from a dry sieve to a wet sieve. This change increased the amount of fines retained in the 200 sieve. This is the reason many of the samples failed. The installer provided the original paper work for two of the sites and the sieve reports that were provided by the gravel companies show that the sand did meet the standards in force at that time. To attempt to investigate each site for original paperwork would have been extremely time consuming and costly. Time and resources did not allow further follow-up.

Column 5 shows the average BOD_5 for the twenty-one sites was 141 mg/L, with a range from 216 mg/L to 26 mg/L. The low BOD_5 was collected at a site with a small cabin on the water, and appeared to have very little use. Groundwater infiltration was also very possible.

Column 6 shows the BOD_5 of the effluent leaving the sand filters and the in-ground mound. The average BOD_5 was 5.5 mg/L, with a range from 21.2 mg/L to 1 mg/L.

The gallons per day (GPD) the system was designed to treat are shown in column 7. The number of bedrooms in the homes determined all GPD. The average is 454 GPD, with a range from 480 GPD to 360 GPD. Note: all sand filter systems have the same design-loading rate of 1.2 gallons per square foot per day.

Column 8 shows the true GPD each site was using. The average is 189 GPD, with a range from 446 GPD to 59 GPD. These flows were determined from hour meters installed at each site or from water meters when available.

Total BOD_5 loading to the filter is shown in column 9. The product of true flow and BOD_5 determine the total BOD_5 load. The average total BOD_5 load was .20 lb/day; with a range from .65 lb/day to .02 lb/day.

Column 10 is the total BOD_5 loading per square foot per day. In the past this element has been ignored, but may be very valuable information when evaluating any on-site system. To determine the true load BOD_5 per square foot you must first determine the true flow of the system and the BOD_5 the sand or soil is receiving. True BOD_5 loading per square foot is the product of the GPD x BOD_5 x .00000834 and dividing the answer into the square foot area of the sand filter or other disposal system. For example: assume

(1) the GPD = 200

(2) the $BOD_{5} =$ 140

(3) soil system or filter size = 375 square feet.

Then:

200 GPD x 140 BOD_5 x .00000834 = .23 PPD and,

23 (PPD) ÷ 375 (ft^2)= .0006. PPD/ft^2.

This gives you the BOD_5 load per square foot, per day to the soil system or the sand filter.

Column 11 is the true hydraulic loading per square foot. In this study, the average is .48 gallons per square foot per day and the range is from 1.11 gallon per square foot per day to .14 gallons per square foot per day. All 21 sites in this study were designed at a 1.2 gal per square foot per day.

Part I Evaluation – Table II

The eight sand filter systems that were found surfacing and/or ponding are shown in Table II. It shows the same values as Table I with one addition, Column 2. This shows that all eight systems were either failing or near failure. Surfacing indicating failure and ponding indicating near failure.

The average age of the eight systems is again 3.5 years. The average age of the four systems that were ponding and surfacing is four years while the average age of the systems ponding only is three years old.

Column 3 indicates the use of time controllers. Systems with approved time controllers set correctly are shown as "1". Systems that had either unapproved timers or approved timers set incorrectly are shown as "1 /" and "0" indicates timers were not used and the system was operating as a demand system. Of the eight systems, only three were found to have approved timer controllers set properly.

Column 4 shows that only four of the eight systems passed the current C-33 sieve test. The four failed in the 100 or 200 sieve indicating there were more fines present than allowed.

Column 5 shows the average sand filter influent had a BOD_5 of 252 mg/L with a range from 416 mg/L to 150 mg/L.

Column 6 shows the septic tank effluent, or sand filter influent BOD_5. Site #26 was an in-ground mound without any way to collect a sample. At site # 28 the flooded bed was leaking into the pump reservoir. This had a major impact on the BOD_5 values. If you include this value in the average of the seven sites the average BOD_5 was 49.9. If you eliminate site # 28 and use the remaining six sites, the average BOD_5 is 14.7. Another challenge to this column may be site #s 22 & 24. Both sites have surfacing sewage and there is no way of determining what percent of the flow was surfacing or what percent of the flow was actually passing through the filter. If you remove these two sites from the study it only leaves four sites, 23, 25, 27 & 29 where 100% of the flow is passing through the filter. The average BOD_5 for these four sites is 17.57 mg/L.

Column 8 shows the average design flows at 472 GPD.

Column 9 shows the true GPD for all sites averaged 220 GPD, with a range from 546 to 114 GPD.

Column 10 shows the total BOD_5 load for each site. The average BOD_5 is .51 lb/day with a range from 1.67 lb/day to .15 lb/day.

Column 11 shows the total BOD_5 per square foot. The average is .00127, with a range from .00410 pounds per day per square foot to .00038.

Column 12 shows the true hydraulic load per square foot. The average is .55 gallons per square foot per day with a range from 1.36 gallons per square foot per day to .28. Again all of these systems were designed with a loading rate of 1.2 gallons per square foot per day.

Part II Renovation with ATUs – Table III

Originally the goal for the Part II study was to include five sites. This proved unexpectedly difficult. Members of the on-site industry were contacted to obtain referrals for sites they felt would benefit from the ATU installations. Five sites were located, however only two sites became available, either because the homeowners did not want to participate in the program or it was felt that a simple repair would alleviate their problem. A third site was found when one site included in the Part I study qualified, and the homeowner was willing to participate. A fourth site was located in an adjacent county.

Site 1

The first ATU installed was at a site that had a mound system as the disposal component of the on-site system. The homeowner had purchased the property one-year prior to the study. Aqua Test, Inc. had been employed to inspect the system three to six months after the new owners moved into the home and found that the mound was surfacing. Ponding was also found when the inspection routine was performed. The septic tank had just been pumped out so lab tests were not drawn at the time of the first visit. A sample was collected at a later date showed the BOD_5 was 174 mg/L. The owner did not fill out the questionnaire but reported that there were three people in the household, herself, her husband, a child, and she was a stay at home mother. She stated that she did use a lot of cleaning products and that they had never lived in a home serviced by a septic system before. She agreed to participate in the Part II study, but after construction started she would not allow an access port installed over the inlet of the septic tank. She thought it would ruin the looks of her lawn. Because of this, an influent baseline sample was not collected at the time the ATU was installed. Had the owner stated her objection before construction was started, the site would have been eliminated from the study. The day the ATU was installed, there was three inches of ponding in the mound. During the nine follow-up site visits, zero ponding was reported.

Site 2

The second site selected for an ATU installation also had a stressed mound. The ponding level in the mound was measured as 3" and effluent had surfaced on one occasion. The homeowner was very cooperative and filled out the questionnaire. This revealed that there were seven people living in the home and the average flow was 325 GPD. On the day the ATU was installed there was over three inches of ponding. Eight follow-up visits recorded zero ponding.

Site 3

The third site selected incorporated a sand filter with a thick organic biomat which resulted in the effluent ponding on the surface daily. The homeowner reported they had purchased the home a little over a year prior. There were three people living in the home and the average flow was 157 GPD. The owner also reported the system had a bad odor daily. The sand filter was ponded and surfacing at the time of the ATU installation. The first follow-up visit, seven days after the ATU was installed found the sand filter was still ponded but there was no surfacing. This site was selected late in the program so there were only four follow-up visits and at the time of the last visit there was four inches of ponding but no surfacing. Note: the normal practice for this ATU installation is to pump out the ponded liquid in a sand filter at the time of installation, but for the purpose of this study, the sand filter was left untouched.

Site 4

The fourth ATU was installed at a home served by a failing sand filter. The owner reported the system was designed to handle 360 GPD and they were using 188 GPD. However, sewage had surfaced eight times in the past twelve months and it was currently surfacing out of the top of the sand filter. One of the occupants of the home had been on antibiotics for a very long time. On the day the ATU was installed, the sand filter was surfacing. This sand filter was not pumped out at the time of installation. Six days after installation of the ATU the system was still ponded but not surfacing. This was still the condition through the completion of the project. As this site was also selected late into the study, there were only four follow-up visits.

This study demonstrates that reducing the BOD5 loading to the interface can enhance the performance of sand filters. Sand filters and ATUs offer an additional option to professionals in the on-site industry. The use of these alternatives helps to render on-site systems as a permanent solution to waste water management needs. The study of these systems indicates that all of the options evaluated require regular inspections, routine maintenance, and process monitoring. The true value of this study is to confirm these three important requirements.

(1) Site #	(2) Age of Home	(3) Timer was Properly Installed	(4) Passed C-33 Test	(5) BOD5 SF Inf.	(6) BOD5 SF Eff.	(7) Dsg. GPD	(8) True GPD	(9) Total Organic Load ppd	(10) Total Organic Load ppd per sq./ft.	(11) True Hyd. gal/day per sq./ft.
1	3	1	1	208.00	8.05	450	149	0.25	0.00060	0.38
2	3	1	1	177.00	8.74	480	446	0.65	0.00160	1.11
3	2	1	X	192.00	7.52	450	116	0.18	0.00048	0.30
4	3	1 /	1	134.00	6.96	450	377	0.42	0.00110	1.00
5	6	1	1	185.00	3.32	450	124	0.15	0.00040	0.31
6	3	1 /	1	216.00	3.65	450	158	0.28	0.00060	0.39
7	3	0	X	141.00	13.50	480	186	0.21	0.00052	0.46
8	5	1 /	X	107.00	7.25	450	205	0.18	0.00048	0.51
9	4	0	1	195.00	2.40	480	114	0.18	0.00040	0.28
10	5	1 /	X	159.00	8.06	480	155	0.20	0.00050	0.38
11	3	1	X	110.00	21.20	480	190	0.17	0.00040	0.47
12	4	1	1	181.00	1.21	450	93	0.14	0.00035	0.25
13	6	1	1	26.00	1.74	300	77	0.02	0.00006	0.30
14	5	0	X	131.00	5.35	450	77	0.08	0.00020	0.20
15	3	1	1	161.00	3.44	480	129	0.17	0.00040	0.32
16	1	0	X	93.00	1.52	450	264	0.20	0.00050	0.70
17	6	1	X	92.00	1.88	450	218	0.16	0.00040	0.57
18		1 /	X	92.00	4.24	450	320	0.24	0.00060	0.85
19		1	1	63.00	1.00	480	59	0.03	0.00007	0.14
20	3	1 /	X	153.00	IG Bed	480	218	0.03	0.00069	0.54
21	2	1 /	X	140.00	4.65	450	286	0.33	0.00080	0.76
Total	Avg. 3.5 yr	10	10	Avg. 141 mg/L	Avg. 5.5 mg/L	Avg. 454 GPD	Avg. 189 GPD	Avg. .20 ppd	Avg. .00053 ppd per sq./ft	Avg. .4[illegible] gal/day per sq./ft

(1) Site #	(2) Age of Home	(3) System was Ponded	(4) Timer was Properly Installed	(5) Passed C-33 Test	(6) BOD5 SF Inf.	(7) BOD5 SF Eff.	(8) Dsg. GPD	(9) True GPD	(10) Total Organic Load ppd	(11) Total Organic Load ppd per sq./ft.	(12) True Hyd. gal/day per sq./ft.
22	7	P & S	1 /	1	169	41	450	157	0.22	0.00059	0.41
23	3	P	1	1	416	26.8	480	272	0.94	0.00230	0.68
24	2	P& S	1	1	352	4.1	480	149	0.43	0.00100	0.37
25	4	P	1	1	186	35.8	480	116	0.18	0.00045	0.29
26	3	P & S	0	X	162	///	480	114	0.15	0.00038	0.28
27	3	P	1 /	X	150	1.95	450	260	0.32	0.00080	0.69
28	4	P & S	1 /	X	368	235	480	546	1.67	0.00410	1.36
29	2	P	0	X	180	5.83	480	152	0.22	0.00055	0.38
TOTAL	**Avg. 3.5 yr**	**8 Pnd. + 4 Surf.**	**3**	**4**	**Avg. 247 mg/L**	**Avg. 49.9 mg/L**	**Avg. 472 GPD**	**Avg. 220 GPD**	**Avg. .5 ppd**	**Avg. .00127 ppd per sq./ft.**	**Avg. .5 gal/ day per sq./ft.**

(1) Site #	(2) Age of Home	(3) System was Ponded	(4) Timer was Properly Installed	(5) Passed C-33 Test	(6) BOD5 ATU Inf.	(7) BOD5 SF Inf.	(8) BOD5 SF Eff.	(9) Dsg. GPD	(10) True GPD	(11) Total Org. Load ppd	(12) Total Org. Load ppd per sq./ft.	(13) True Hyd. gal/ day per sq./ft.
1 Mound	4	P	1	X		174	Mnd	480	232	0.33	0.00080	0.58
After ATU		0	1			80.6			232	0.15	0.00038	0.58
2 Mound	4	P	1	1		226	Mnd	450	325	0.61	0.00162	1.16
After ATU		0	1		282	22.7			266	0.05	0.00013	0.7
3 Sand Filter	7	P & S	1	1		169	41	450	157	0.22	0.00059	0.41
After ATU		P	1		221	50.6	14		157	0.06	0.00017	0.41
4 Sand Filter	7	P & S	0	1		210	31.1	360	188	0.31	0.00100	0.62
After ATU		P	0		200	44.2	36.5		188	0.06	0.00020	0.62
AVG. Before ATU	**5.5 yrs**		**3**			**Avg. 194 mg/L**			**Avg. 225 GPD**	**Avg. .36 ppd**	**Avg. .0010 ppd per sq./ft**	**Avg. .69 gal/ day per sq./ft**
AVG. After ATU			**3**		**Avg. 219**	**Avg. 49.5 mg/L**			**Avg. 210 GPD**	**Avg. .07 ppd**	**Avg. .0002 ppd per sq./ft**	**Avg. .57 gal/ day per sq./ft**