#8.24

SMALL SCALE WASTE MANAGEMENT PROJECT

Renovating Failing Septic Tank-Soil Absorption Systems Using Aerated Pretreated Effluent

by

James C. Converse, E. Jerry Tyler

1994

UNIVERSITY OF WISCONSIN - MADISON
College of Agricultrual & Life Sciences
Agricultural Engineering
Food Research Institute
Soil Science
School of Natural Resources
Environmental Resources Center
College of Engineering
Civil & Environmental Engineering

Copies and a publication list are available at:
Small Scale Waste Management Project, 345 King Hall
University of Wisconsin - Madison, 53706 (608) 265 6595

RENOVATING FAILING SEPTIC TANK-SOIL ABSORPTION SYSTEMS USING AERATED PRETREATED EFFLUENT

J.C. Converse, E.J. Tyler*

ABSTRACT

Failing septic tank soil absorption systems were renovated by installing aerobic treatment units after the septic tank to produce a highly pretreated effluent with low BOD and suspended solids. Fifteen systems were identified and evaluated for hydraulic performance. Twelve of the 15 soil absorption units successfully accepted all of the treated wastewater after installation of the aerobic unit. One system was vastly overloaded; another system needed some pumping during the first six months and the third system continues to need some pumping 9 mo. after the aerobic unit was installed. It also has experienced some aerobic unit start up problems. As a result of this study, the State allows the installation of aerobic units or sand filters for the purpose of renovating failing soil absorption systems provided the sites meet soil and site separation distances required.
Keywords: Renovation, Pretreated effluent, On-site systems.

INTRODUCTION

Septic tank-soil absorption systems will form a biological mat at the soil infiltrative surface which reduces the wastewater infiltration rate. There are many biological factors that affect mat development such as hydraulic and organic loading rates, temperatures and age. Much research has been done to identify the components. Siegrist et al., 1991 discuss the humic substance formation during wastewater infiltration in soil absorption systems. Wong (1994) is attempting to identify the various bacteria involved in mat formation.

When the hydraulic loading rate exceeds the wastewater infiltration rate, septic tank effluent begins to pond in the system. If this process continues, the net result is septic tank effluent backing up into the home or breaking out on the ground surface. Resting for long periods of time will renovate the system but during that time alternative effluent handling methods are required. Some researchers have used hydrogen peroxide or other oxidizing agents to break up the mat but it may decrease the wastewater infiltration rates significantly (Hargett, et al., 1984. Mickelson, et al., (1989) showed that hydrogen peroxide is effective in reducing the clogging mat in clean sands for 1 or 2 times after which it is no longer effective. Lower organic loading rates will retard the development of the biomat (Siegrist, 1987).

If the organic loading rates could be reduced by effluent pretreatment through a sand filter or aerobic unit prior to entering a failing soil absorption system, it may be possible to continue to use the system at the same hydraulic loading rate while the system is undergoing renovation through biological decomposition.

The objective of this study was to determine how effectively aerobically treated effluent renovated soil absorption systems which had failed due to biological mat formation. Aerobically pretreated effluent is defined as effluent exiting a normally operating aerobic unit or sand filter with typical BOD and SS values less than 10-15 mg/L.

---

*J. C. Converse, Professor and Chair, Agricultural Engineering Department and E.J. Tyler, Professor, Soil Science Department, UW-Madison. Research supported by the College of Agriculture and Life Sciences and the Small Scale Waste Management Project.

MATERIALS AND METHODS

In 1987 an aerobic unit was installed with the effluent entering a failing soil absorption unit. Two other units were installed in 1990. Based on preliminary results of these three sites, the State of Wisconsin in 1991 allowed homeowners to install pretreatment units, capable of producing highly pretreated effluent, for the purpose of renovating failing soil absorption units. However, the soil absorption unit must meet the separation distance required of all soil absorption units which is 3 ft of separation between the aggregate/soil interface and the high water table or bedrock (Burks, 1991).

In February 1994, the authors contacted county sanitarians for a list of sites using highly pretreated effluent to renovate failing systems with 17 sites identified. A telephone and written survey instrument were developed for the homeowner and installer, respectively. There was 100% response to the surveys.

RESULTS AND DISCUSSION

System Characteristics

Table 1 gives the site characteristics for 15 units of the 17 systems identified. Two systems were not included in the study as the systems were not failing prior to installation of the aerobic units and one of the two systems was serving a summer home. Fourteen of the systems served homes and one served a town hall. The ownership and number of people served remained the same prior to and after installation of the aerobic unit except at Site 2 where the number of people served remained the same. The owner survey also indicated that the water use prior to and after installation was essentially the same. At Site 2 the owner indicated more water was used after installation and at Site 14 less water was used. In the latter case, the system is one of the two systems that does not appear to be working correctly. At Site 1 the water softener discharge was diverted elsewhere, and at Site 9 the basement sump was disconnected from the system.

The symptoms varied from backup in the basement, to severe ponding with no breakout to breakout on the ground surface. In all but one case (Site 14) the symptom disappeared after installation of the aerobic unit with reappearance of symptoms in 5 cases. In all but two cases (Sites 14 and 15) the homeowners were satisfied with the performance.

Table 2 summarizes the symptoms before and after the installation of the aerobic unit. In two of the cases the symptoms reappear during spring wet weather and three of the systems needed occasional pumping. Systems 9 and 10 are in high ground water sites. System 9 ponded during Spring 1993 but did not during Spring 94. System 10 exhibited a small spongy spot during Spring. Each system accepted all of the wastewater without requiring pumping. Within a few weeks ponding disappeared. Samples of ground water taken twice in Spring 1994 (Site 9) from the 4 observation wells surrounding the soil absorption unit showed fecal coliform counts below detectable levels. The drywell on Site 6 needed periodic pumping for 6 months then accepted all of the waste water. At Site 14 the system is still experiencing problems 9 months after installation of the aerobic unit. The aerobic unit has experienced start up problems and the system continues to need periodic pumping but probably on a less frequent basis. At Site 15, less frequent pumping occurred after installation of the aerobic unit, but the drywell was vastly undersized for the amount of effluent entering it. It should be noted that the vent tube extends only to the distribution pipe which is typically 6 - 12 in. above the aggregate/soil interface while the observation tube monitors ponding to the aggregate/soil interface. Thus if ponding disappeared in the vent tube, there could still be ponding below the distribution pipe.

Table 1. Home and System Characteristics and Performance

Site	No. Bedrm	House Size (ft²)	Population	Water Appliance	System Type-Date (ft)	System Size	Water Use	Symp tons	Symp Disappear	Symp Reappear	Owner Satisfied
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1	3	2-3000	2(3)	D,W,G	M-78(2-93)	5X94	S/L	P	Y	N	Y
2	3	2-3000	2(2)*	D,W,G	M-86(4-92)	8X47	M	P	Y	N	Y
3	2	2000	2(1)	D,W,G	B-78(5-90)	24X34	S	B	Y	N	Y
4	3	2-3000	2(0)	D,W,S	B-75(6-90)	6X58	S	B	Y	N	Y
5	3	2-3000	2(0)	D,W,G,S	B-85(4-91)	12X52	S	B	Y	N	Y
6	3	1-2000	2(1)	W	D- -(4-91)	-	S	L	Y	P	Y
7	3	1-2000	2(1)	D,W,G,S	T-77(10-93)	5X110	S	B	Y	N	Y
8	3	1-2000	2(2)	D,W,S	T- -(2-92)	5X62	S	L	Y	N	Y
9	4	1-2000	2(1)	W,S	B-72(7-92)	18X62	S/L	P	Y	S	Y
10	4	>3000	2(3)	W	B-75(10-91)	14X47	S	L	Y	S	Y
11	3	1-2000	2(2)	W,S	T-60(8-87)	-	S	L	Y	N	Y
12	3	2000	2(2)	D,W	B-73(5-92)	20X38	S	L	Y	N	Y
13	T.H.	-	Same	-	B-74(5-92)	20X35	S	L	Y	N	Y
14	4	2-3000	2(4)	D,W	B-74(10-93)	18X30	L	L	N	P	S
15	5	2-3000	2(5)	-	D- -(8-90)	-	S	L	Y	P	S

Notes:

Col. b-T.H.-Town Hall with offices with 4 employees and meeting rooms.

Col. c-2-3000 means house size between 2000 and 3000 sq. ft.

Col. d-Number of adults (number of children), *ownership change at time of aerobic installation.

Col. e-Appliances: D (dishwasher), W (Washer), G (Garbage Grinder), S (Softner discharge to unit).

Col. f-B-Bed, M-Mound, T-Trench, D-Drywell, year original system installed (date aerobic unit installed).

Col. g-System size was taken from plans on file in county offices. Drywell units are single units with unknown dimensions, typically 6-10 in diameter 8-9 ft from ground surface.

Col. h-Water usage before and after based on homeowner opinion. S(Same), M (More), L(Less), S/L(Same use in house, less to system).

Col. i-P-Ponding, B-Backup, L-Breakout on Lawn.

Col. j-Symptoms disappear; Y(Yes), N(No)

Col. k-Symptoms reappear; Y(Yes), N(No), S(Seasonal), P(Occasional pumping) after aerobic unit installation.

Col. l-Owner satisfied; Y(Yes), S(Somewhat)

Table 2. Description of Symptoms before and after Installation of Aerobic Unit

Site	System Type	Infiltration Area Condition: Prior to Aeration	Infiltration Area Condition: After Aeration	Comments
1	Mound	At least 6-8 months severe ponding.	No ponding after 6 months, dry in July, 94.[a]	Diverted softener discharge elsewhere after aerobic unit installed.
2	Mound	Mound ponded.	No ponding after 6 months, dry in July, 94.	New owners indicated previous owners practiced water conservation for extended period, uncomfirmed.
3	Bed	Ponding for some time,backed up in house.	In-ground bed dry.	Aerobic unit installed within 90 days of backup.
4	Bed	Ponding for some time, backed up in house	Ponding continues for several years (Fig. 1)	Septic tank pumped for a month before aerobic unit installed.
5	Bed	Ponding with intermittent back up in house for 3 years.	Bed dry in July, 94.	Septic tank pumped frequently for 3 years before aerobic unit installed.
6	Drywell	Ponding with breakout on lawn in winter at end of trench connected to drywell.	Drywell needed periodic pumping for 6 months, about 5 1/2 in. of effluent in drywell in July 94.	Aerobic unit installed within 6 mo. after detecting problem. Trench disconnected at time of aerobic installation.
7	Trench	Ponding with intermittent back up in house for 6 years.	Noticeable drop in ponding within 2 weeks. There was about 2" of ponding 6 mo. later. Dry in July, 94.	No further backup into home.
8	Trench	Ponding with breakout on lawn for about 6-8 months.	Symptoms disappear with ponding in vent tube disappearing in 3 mo. No effluent in vent in July, 94.	There could be ponding in trench as vent tube doesn't extend to base.

Table 2. Continued

9	Bed	Ponding in vent tube to about 6" of ground surface.	No ponding shortly after installation but ponded during Spring 93 due to high water table, basement sump and wet spring. No ponding in Spring 94. Dry in July, 94 but some ground water in 3 of 4 wells.	Installed observation tubes to bottom of system. Basement sump pumped into system until Summer 93. Spring 94 drier but water table did rise into wells which were installed around system. Water table recedes in summer.
10	Bed	Ponding with effluent surfacing on lawn.	No surfacing but ponded in Spring due to high water table. Vent tube dry in July, 94.	Spot, where previously surfaced, spongy in Spring but dry rest of year.
11	Trench	Ponding with breakout through distribution box for one year.	Ponding continued in trenches for several years. (Fig. 2).	Trenches are probably undersized for home.
12	Bed	Ponding with breakout for 3 years. with septic tank pumping quarterly.	Observation tubes indicate 6-8 in. ponding from Dec.-April and 2-4 in. for May-Nov. There was 4-6 in. of ponding in July, 94.	Soil added to breakout point as low. No more break out.
13	Bed	Ponding with septic tank pumped frequently. Effluent standing in distribution box which sits in aggregate of bed.	No ponding in distribution box as of Spring 94. In July 94, effluent just below aggregate surface.	System accepting all effluent with no septic tank pumping.
14	Bed	Ponding with periodic bleeding through retaining wall at end of system.	System continues to need periodic pumping with 15 in. of pond and no bleeding to surface as of July, 1994.	Problems in getting aerobic unit started.
15	Drywell	Ponding with periodic breakout to lawn for several years.	Ponding continued with occasional pumping until large family moved. No further pumping required with only one person.	Drywell vastly undersized for amount of effluent added.

[a]Authors visited all but Site 3 in June and July 1994 to verify performance. Other data is result of interviews of owners and contractors.

Construction Details

All soil absorption units except two (Site 2 and 3 in Table 3) were pumped prior to the system coming on line after the new pretreatment unit was installed. This allowed the system to start its renovation process and provided some storage capacity in the aggregate. Table 3 gives a summary on how effluent was removed from the soil absorption unit. Effluent was drained from about half of the systems by cutting into the side of the systems, allowing the effluent to flow into the cut and then pumped. The rest were pumped from the distribution box or observation tubes.

Table 3. Effluent removal from the soil absorption unit.

Site	Pumped	Description
1	Yes	Mound with 2 observation tubes, pumped through tubes.
2	No	Mound
3	No	In-ground bed
4	Yes	In-ground bed, cut into side
5	Yes	In-ground bed, pumped through observation tubes
6	Yes	Drywell, pumped it
7	Yes	In-ground trench, cut into side
8	Yes	In-ground trench, cut into side
9	Yes	In-ground trench, cut into side
10	Yes	In-ground bed, pump from distribution box, accidently cut into side of bed during installation of aerobic unit.
11	Yes	In-ground trench, pump from distribution box
12	Yes	In-ground bed, cut into side
13	Yes	In-ground bed, pumped from the distribution box
14	Yes	In-ground bed, cut into header pipe
15	Yes	Pumped dry well

Long Term Monitoring

Two systems were monitored for several years to evaluate how the systems responded to aerobically treated effluent. Site 4 has two vent tubes with the effluent entering the center of the bed. Both vent tubes, which extended to the distribution pipe and not the bottom of the bed, exhibited ponding prior to the installation of the aerobic unit. The bottom of the vent tubes are not at the same elevation thus inferring that the bottom of the bed is not level. After the system was pumped and the aerobic unit installed (Day Zero) only one of the vent tubes has exhibited ponding with the liquid levels shown in Fig. 1 for several years. The liquid level fluctuated between 20 and 38 cm (8 - 15 in.) for about 1000 days and then started to drop. The times that the vent pipe was dry coincided with the owners on vacation. The system has accepted all of the wastewater after installation of the aerobic unit.

Figure 2 shows the ponding depth with time for Site 11. Effluent was flowing out of the distribution box for about a year before the aerobic unit was installed at Day Zero. However, for a few months prior to Day Zero, the septic tank was pumped for several weeks to measure ponding response through the observation tubes located at the aggregate/soil interface. There was a decrease in ponding level prior to Day Zero when no effluent was entering the system. Immediately after the aerobic unit was installed the ponding level rose with a gradual decrease over 2000 days, around which time one or more of the observation tubes were reported dry. These measurements are the average of 2 observation tubes, in each of two trenches served by a common distribution box. Although the size of this system is not known, it is believed to be undersized for the home size and the soil conditions. Had the proper size soil absorption been installed according to current standards, it is believed that the liquid level would have dropped much faster as observed in other systems (Table 2). The system accepted all of the wastewater after the aerobic unit was installed.

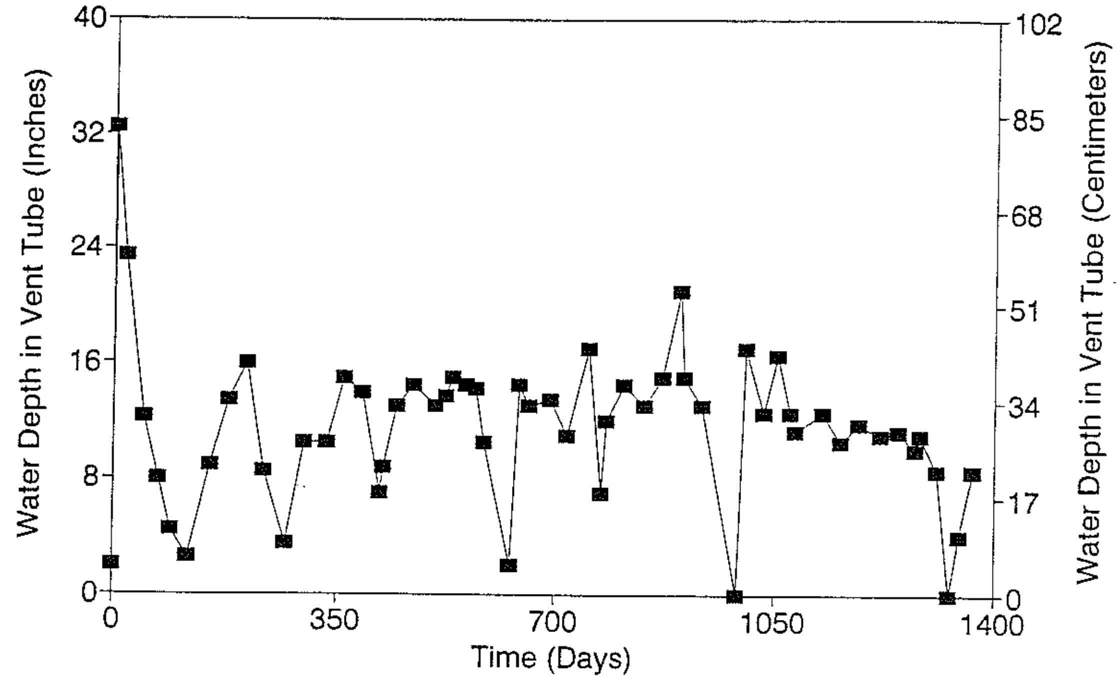

Figure 1. Ponding Depths in Soil Absorption Bed With Time for Site 4. Depth Zero Represents the Invert of the Distribution Pipe, not the Bottom of the System.

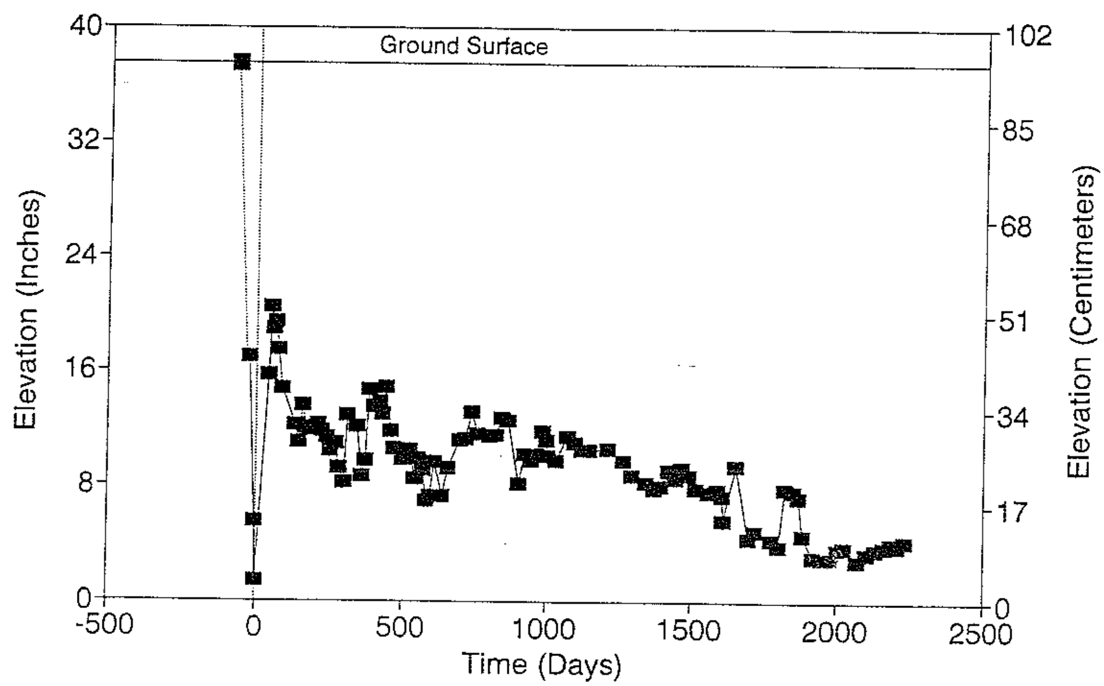

Figure 2. Ponding Depths in Soil Absorption Bed with Time for Site 11 to Bottom of System.

SUMMARY AND CONCLUSIONS

This study evaluates the concept of adding aerobically treated effluent with low BOD and suspended solids from aerobic units in an attempt to renovate the soil absorption unit. Aerobic units were installed behind the septic tank in fifteen units in which the effluent was backing up into the house, ponding in the absorption unit or breaking out on the ground surface. In most cases the only alteration was the installation of the aerobic unit and pumping of the soil absorption unit. Thirteen of the 15 units have accepted all of the wastewater added after installation of the aerobic unit. The dry well on one system was vastly undersized for the amount of effluent added and needed occasional pumping. Another system needed occasional pumping for only 6 months at which time it started to accept all of the waste water. The soil absorption unit at another site needs occasional pumping 9 mo. after the installation of the aerobic unit. The aerobic unit has experienced some start up problems. Taking into account these limitations, it appears that failing soil absorption systems can be successfully renovated by adding aerobically pretreated effluent.

As a result of this study, the State of Wisconsin is allowing systems that are failing due to clogging mat development to be renovated using aerobically treated effluent from aerobic units or sandfilters provided the site meets separation requirements between the aggregate/soil interface and limiting conditions of highwater table or bedrock.

REFERENCES

1. Burks, B. 1991. Aerobic wastewater treatment units. Letter sent to Private Sewage Staff and County Code Administrators. Dept. of Industry, Labor and Human Relations, Bureau of Building Water Systems, 201 East Washington Ave. Room 141, P.O. Box 7969, Madison, WI 53707.

2. Hargett, D.L., E.J. Tyler, J.C. Converse and R.A. Apfel. 1984. Effects of hydrogen peroxide as a chemical treatment for clogged wastewater absorption systems. In: On-site Wastewater Treatment. Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems. ASAE, 2950 Niles Road, St. Joseph, MI. 49085.

3. Mickelson, M., J.C. Converse and E.J. Tyler. 1989. Hydrogen peroxide renovation of clogged wastewater soil absorption systems in sands. Trans. of ASAE, 32(5):1662-1668.

4. Siegrist, R.L.. 1987. Hydraulic loading rates for soil absorption systems based on water quality. In: On-site Wastewater Treatment. Proceedings of the Fifth National Symposium on Individual and Small Community Sewage Systems. ASAE, 2950 Niles Road, St. Joseph, MI. 49085.

5. Siegrist, R.L., R. Smed-Hildmann, Z.K. Filip, P.D. Jenssen. 1991. Humic substance formation during wastewater infiltration. In: On-site Wastewater Treatment. Proceedings of the Sixth Symposium on Individual and Small Community Sewage Systems. ASAE, 2950 Niles Road, St. Joseph, MI. 49085.

6. Wong, A.C., 1994. Personal Communications. Food Microbiology and Toxicology, University of Wisconsin-Madison, Madison, WI. 53706.