Multi-Flo Performance

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Summary:

The Multi-Flo FTB-Series of onsite wastewater treatment systems produce an effluent that has less than 10 mg/L $CBOD_5$ and TSS and a fecal coliform less than 1,000 cfu/100 mL. Current testing in Minnesota confirms fecal coliform removal. This effluent quality is so high that only one foot of soil is sufficient to reduce all effluent quality parameters to background readings.

Multi-Flo FTB-Series

The Multi-Flo FTB-Series has been in continuous production since the early 1970's when it was designed. The series was developed by Tait Pump Company and acquired by Consolidated Treatment Systems, Inc. (CTS) in the early 1980's. CTS has manufactured the series ever since. Figures 1 and 2 show the FTB 0.5, which has a rating of 500 gpd and typifies the series.

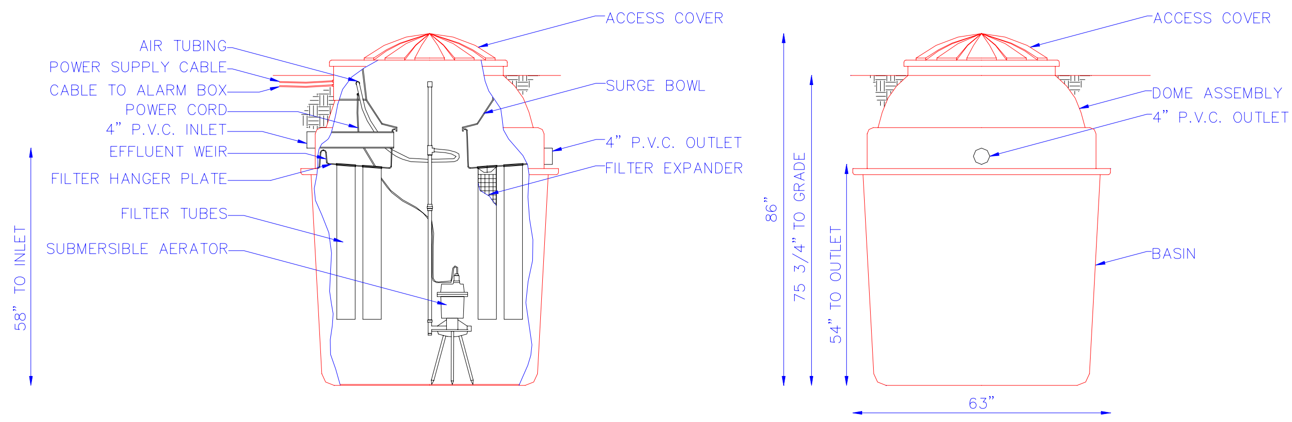

Figure 1—Multi-Flo FTB 0.5, Elevation View

The FTB-Series design is based on the continuously-stirred extended aeration, activated sludge process, which is a standard design approach perfected for municipal-scale wastewater treatment.[1 2] The process works as follows: influent wastewater discharges into a tank designed to hold one day's flow. In the tank, an aerator continuously mixes and adds oxygen to the wastewater. The mixing and oxygenation facilitate the growth of microorganisms that oxidize organic material and consume pathogens in the wastewater.

Unique to the Multi-Flo are its thirty "socks." These socks perform two functions. First, the socks filter the wastewater before discharge. The socks have a nominal rating of 100 microns. As the unit matures, filtration becomes finer, such that the effluent is clear. Second, the socks provide a growth medium for additional microorganisms that provide additional wastewater treatment as wastewater flows through them. These microorganisms consume remaining organic material and pathogens, leaving the effluent virtually free of organic material, solids, and pathogens.[3]

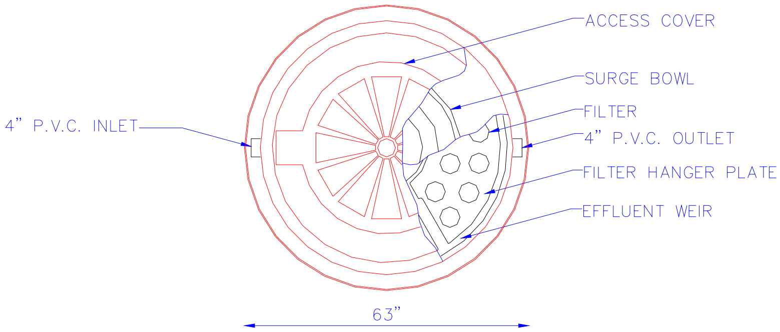

Figure 2—Multi-Flo FTB 0.5, Plan View

Multi-Flo Performance

Multi-Flo was among the first onsite wastewater treatment units to be certified under ANSI/NSF Standard 40 [4]. This standard, which is the National American Standard for onsite wastewater treatment unit, sets minimum effluent quality at 25 mg/L $CBOD_5$ and 30 mg/L TSS. [5 6 7] Multi-Flo was first certified under NSF Standard 40 in 1974. At that time the average effluent BOD was 4 mg/L, and the effluent TSS was 6 mg/L, both values representing a 98 percent removal. [8] The series was again tested in 1981. At that time, the average effluent BOD5 was 8 mg/L while the effluent TSS was 7 mg/L, representing a 96 percent removal. Under testing conducted in 1997, the Multi-Flo FTB-Series is certified with an average effluent $CBOD_5$ and TSS of 6 mg/L each. [9]

Fecal coliform, an indicator of potential pathogens in wastewater, is not a part of the ANSI/NSF Standard 40 certification process. Still, jurisdictions are considering this parameter during product review. Presently, the State of Wisconsin recognizes that Multi-Flo has an effluent quality of 171 cfu/100 mL. [10] Performance data for the Multi-Flo FTB-0.5 is summarized in Table 1.

Table 1—Multi-Flo Effluent Performance [11 12]

Parameter	NSF, 1974	NSF, 1981	NSF, 1998
$CBOD_5$	6 mg/L	8 mg/L	6 mg/L
TSS	6 mg/L	7 mg/L	6 mg/L
Fecal Coliform	171 cfu/100 mL		

University of Wisconsin Studies and Results

Since 1987, Multi-Flo units have been a part of several studies conducted by the University of Wisconsin, Small Scale Waste Management Project. The general themes of these studies have been to document field performance of activated sludge technologies and determine the role effluent quality plays in subsequent soil treatment. The goal was to determine whether alternative soil and sizing criteria could be used based on the quality of the effluent dispersed to the soil. [13] Taking all of the samples into account, the geometric mean effluent BOD is 6.9 mg/L (*n*=377), and the geometric mean effluent fecal coliform is 1,024 col/100 mL (*n*=433). [14]

In 1987, a Multi-Flo unit was installed at a site where the effluent entered a "failing" soil absorption area. "Failing" meant that effluent was ponding in the trenches of the soil absorption system and/or on the ground surface. Installation of this unit was completed in July 1987, and effluent began to leave the unit about a week later. After one year, all of the effluent was still discharging to the previously failed soil absorption area. [15] Two other Multi-Flo units were installed in 1990. All three systems were monitored by the University of Wisconsin. Based on preliminary results, the State of Wisconsin allowed owners to install pretreatment units for the purpose of renovating failed soil absorption areas. [16] In 1994, a follow-up survey of 17 installations was conducted. Based on this survey, University researchers concluded that aerobically pretreated effluent successfully renovates failing soil absorption systems. [17]

A follow-up study was conducted in 1997 to examine the long term performance of the previously failed soil absorption systems. As a part of the follow-up, BOD and fecal coliform sampling was conducted on systems where ponding was observed. The average BOD of the ponded effluent—effluent from Multi-Flo systems—was 11 mg/L, and the average fecal coliform count was 204 col./100 mL. [18] [19] [20]

Simultaneously, Converse and Tyler were examining the relationship between effluent quality and soil hydraulic loading. In 1989, they concluded that long term acceptance rates are affected by wastewater effluent quality; pretreated effluent of high quality can be applied at higher rates than septic tank effluent. [21]

Using the information as a part of further studies, Converse and Tyler examined soil treatment of 37 full-time residences using Multi-Flo units discharging into modified mounds. Thirty-six of the units were sampled for BOD_5 and fecal coliform. The median effluent BOD_5 was 10 mg/L; the average BOD_5 was 19 mg/L. The median effluent fecal coliform was 1000 MPN/100 mL while the average fecal coliform was 28,000 MPN/100 mL. [22] Converse and Tyler reported both numbers because the wide variation in data. Wide variations can result from sampling errors, which are easy to commit given the general conditions under which sampling occurs and the sensitivity of the analysis. One high value could skew the results. [23] [24] Regardless, Converse and Tyler report that the median fecal conform count is below detectable levels within six inches after the effluent enters the soil. [25] Even where the median coliform count is 10,000 MPN/100 mL or fewer, fecal coliform was not detected at distances greater than 12 inches, even when the hydraulic loading rate was doubled over code-specified hydraulic loading rate. [26]

Converse and Tyler continued and refined their studies of Multi-Flo units. In 1999, they reported results of 21 Multi-Flo units that had been the subject of previous studies: Multi-Flo units could be placed on six inches of suitable soil and have no detectable fecal counts 90 percent or more of the time even if the Multi-Flo had an effluent quality of 1000 col./100 mL or less only 50 percent of the time. [27] In this study, Converse and Tyler reported the Multi-Flo units (identified as Unit B in the study) had a median fecal coliform count of 530 col./100 mL and an average fecal coliform count of 10,000 col./100 mL. [28 29 30 31]

The information from related studies was summarized in a separate publication that provides both hydraulic loading and soil separation information. Where the BOD_5 and TSS are both equal to or below 30 mg/L, hydraulic rates can be increased from 150-to-200 percent over corresponding soils receiving septic tank effluent. When effluent fecal counts are 1000 cfu/100 mL or less, separation distances can be reduced to as little as 12 inches. [32]

University researchers had based their previous research on traditional effluent distribution systems, both gravity and pressure distribution. With the emergence of drip irrigation technology, the researchers wanted to see whether their conclusions were applicable to drip irrigation. To this end, they conducted a study of two Multi-Flo units using drip irrigation for effluent dispersal. The median effluent quality data for each unit is shown in Table 2. [33]

Table 2—Median Multi-Flo Performance at Two Study Sites

Parameter	Jackson County	Rock County
BOD_5	20 mg/L	1 mg/L
TSS	25 mg/L	2 mg/L
Fecal Coliform	600 col./100 mL	37 col./100 mL

In addition to studies focused on traditional performance indicators, one researcher examined the fate of viruses in Multi-Flo units. The study was conducted by "seeding" an onsite wastewater treatment system, which included a septic tank followed by a Multi-Flo, with coliphages and examining for the presence of virus at various points in the system. [34] Coliphages were detected in the effluent of the septic tank but not in the effluent of the Multi-Flo unit. [35]

Current Minnesota Performance

Multi-Flo units have been installed in Minnesota since the early 1970's. Hundreds of systems have been installed statewide, and these systems serve residential and commercial occupancies. Recently, regulators have questioned whether performance claims made elsewhere are reproducible in Minnesota. Recent sampling demonstrates that Multi-Flo units in Minnesota perform as well there as demonstrated elsewhere. Taken together, sampling results from 24 Multi-Flo systems had a geometric mean of 79 cfu/100 mL and a median value of 120 cfu/100 mL. [36]

In December 2001, Steve Schirmers sampled 16 systems in Anoka, Hennepin, and Wright Counties. The oldest system is four years old, and all of the systems serve residential occupancies. Fifteen of the systems serve single-family dwellings, and one system serves a single-family dwelling and attached cabin. Half of the systems are time-dosed while the other half are gravity-fed. He conducted his initial round of sampling on December 5, 2001. All of the samples were taken from above the weir plate.

When this sampling was completed, seven samples showed fecal coliform results in excess of 200 cfu/100 mL. [37] In discussing sampling with the testing laboratory, Mr. Schirmers concluded that he may have accidentally contaminated samples with condensation dripping onto the weir plate. Mr. Schirmers conducted a second round of sampling on December 12, 2001. During the second round of sampling, Mr. Schirmers used sterilized sampling instruments. Only one system showed a fecal coliform value above 200 cfu/100 mL. Sampling results are shown in Table 3.

Table 3—Multi-Flo Performance in Three Minnesota Counties		
Fecal Coliform	**December 5, 2001**	**December 12, 2001**
Geometric Mean	>90 cfu/100 mL	48 cfu/100 mL
Median	>175 cfu/100 mL	64 cfu/100 mL

In October 2001, Rick Weller sampled nine Multi-Flo systems as a part of regulatory requirements in Isanti County. [38] All of the systems serve residential occupancies, and the oldest system is about four years old. Samples were taken from weir plates, drop boxes, or pump tanks, whichever was most convenient. Of the nine samples, only one exceeded the analysis limit of 2,000 cfu/100 mL. Mr. Weller believes a sampling error could easily account for the high value given the variety of sampling locations. Re-sampling was not performed. Table 4 shows results for all samples and with the apparent errant sample removed.

Table 4—Multi-Flo Performance in Isanti County		
Fecal Coliform	**All Results**	**Apparent Valid Results**
Geometric Mean	>274 cfu/100 mL	213 cfu/100 mL
Median	>170 cfu/100 mL	155 cfu/100 mL

The results in Tables 3 and 4 are consistent with results from Converse and Tyler. Accordingly, the results confirm that Multi-Flo units can be installed on sites having as little as 12 inches of separation distance from a limiting factor, such as high groundwater, or on lots too small for conventional septic systems. When separation distances are reduced to 12 inches, loading rates should remain consistent with those site receiving septic tank effluent. When loading rates are increased, separation distances should be adjusted. [39]

Other Research Studies

Multi-Flo performance has been researched by institutions other than the University of Wisconsin. Research has also been conducted by other institutions and jurisdictions. Some research focused on specific performance questions; others were studies to document performance as a part of regulatory requirements. Discussed below are several studies.

East Tennessee State University, 1984. In 1984 East Tennessee State University conducted a field study to see whether Multi-Flo could treat for poliovirus. The study was conducted by seeding a Multi-Flo unit with a known concentration of poliovirus. Composite sampling was then performed to look for poliovirus in the effluent. Nine sampling events were conducted over two weeks. Poliovirus was undetectable in eight of the samples. In the ninth sample, the poliovirus concentration was 5.3 PFU/L, a seven-log removal. Based on their study, the researcher concluded that poliovirus is readily removed by Multi-Flo. [40]

Illinois, 1980. During the summer and fall of 1980, eleven Multi-Flo units were sampled for BOD, TSS, and fecal coliform as a part of studies to determine whether Multi-Flo complies with Illinois environmental protection laws. The median values were as follows: BOD, 5 mg/L; TSS, 14 mg/L; Fecal Coliform, 1500 col/100 mL. The high effluent quality was attributed to quality maintenance the units received. [41]

Lee County, Iowa, 1984-1987. Five Multi-Flo units were sampled as a part of required monitoring. One system was monitored ten times over a period of three years. Other systems were monitored annually or less. Average values were as follows: BOD, 9 mg/L; TSS, 3 mg/L; Fecal Coliform, 3600 col./100 mL. [42]

Florida, 1986. Four Multi-Flo units were monitored to fulfill regulatory requirements. Bi-weekly testing was conducted over a three-month period. Testing covered four models in the FTB-Series and included residential and commercial occupancies. The average BOD was 10 mg/L, and the average TSS was 6 mg/L. [43]

West Virginia, 1988. Four Multi-Flo units were monitored as a part of lake water quality monitoring. In this study, the Multi-Flo units discharge directly into the lake. In this study, the average fecal coliform of the lake, based on samples at predestinated locations, was 2000 col./100 mL. Fecal coliform would include all natural and man-made sources discharging into the lake. In addition, the average fecal coliform from five drainage ditches around the lake was 1200 col./100 mL. The average BOD_5 from the Multi-Flo units was 7 mg/L while the average TSS was 5 mg/L. Fecal coliform samples were not taken from the Multi-Flo units. [44]

Island County, Washington, 1999. Seven Multi-Flo units were monitored as part of a demonstration grant program. Each Multi-Flo unit was sampled four times; sampling frequency was not provided. The average BOD was 3.4 mg/L, and the average TSS was 1.7 mg/L. The average fecal coliform count was 9800 cfu/100 mL. [45]

Conclusion

Numerous studies conducted by the University of Wisconsin, and confirmed by field studies elsewhere, document the superior performance of the Multi-Flo FTB Series. As the data shows, Multi-Flo units can produce an effluent having $CBOD_5$ and TSS values below 10 mg/L. Effluent fecal coliform values may be below detection limits, have been certified at 171 cfu/100 mL in

Wisconsin, and even at higher values, are below detection limits within 12 inches of an infiltrative surface.

Multi-Flo units should be granted treatment credits in the form of reduced separation distances from limiting factors and higher hydraulic loading rates, both in accordance with the manufacturer's recommendations. Combined with proper management, which include periodic maintenance, Multi-Flo will provide superior public health and environmental protection at a lower cost than corresponding technologies sized for the same occupancies.

References and Notes

[1] Tchobanoglous, G. *Wastewater Engineering: Treatment, Disposal, and Reuse*, Third Edition. New York: Irwin/McGraw-Hill, 1991, pp 529-556.

[2] Tchobanoglous, G. and Crites, R. *Small and Decentralized Wastewater Management Systems.* New York: WCB/McGraw-Hill, 1998, pp 451-482.

[3] Specific $CBOD_5$, TSS, and fecal coliform data to be detailed throughout this document.

[4] ANSI/NSF Standard 40-Residential Wastewater Treatment Systems. NSF, International, 789 Dixboro Road, Post Office Box 130140, Ann Arbor, MI 48113-0140

[5] $CBOD_5$ means five-day carbonaceous biochemical oxygen demand, a measure of the organic material in the wastewater.

[6] Throughout this document $CBOD_5$, BOD_5, and BOD are used interchangeably.

[7] TSS means Total Suspended Solids, a measure of suspended (as opposed to dissolved) solid material in the wastewater.

[8] Summary of NSF Report S40-5 as appended to NSF Test Data for Multi-Flo Model FTB-0.5, dated October 22, 1981.

[9] "Performance Evaluation Report: Multi-Flo Model FTB-0.5 Wastewater Treatment System." Ann Arbor: NSF International, May 1998, p 10.

[10] Email, dated September 19,2001, from Mike Beckwith, Wisconsin Department of Commerce.

[11] "Performance Evaluation Report: Multi-Flo Model FTB-0.5 Wastewater Treatment System." Ann Arbor: NSF International, May 1998, p 10.

[12] Burks, B. and Minnis, M. *Onsite Wastewater Treatment Systems.* Madison: Hogarth House, Ltd., 1994, p 51.

[13] This author administered Wisconsin's onsite wastewater management program from 1989 to 1996, administered its inspection program from 1989 to 2000, and administered its failing septic system replacement grant program from 1992 until 2000. Reducing the size, cost, and restrictions for onsite wastewater treatment was and remains a priority of the onsite wastewater management program. In 2000, the revised Comm 83, which regulates onsite wastewater management, has incorporated effluent quality as a part of the design requirements and applies treatment "credits" for high quality effluent.

[14] Converse, J. "Multi-Flo Data Summary of All Samples Collected From 23 Sites." Madison: University of Wisconsin, Small Scale Waste Management Project, May 1, 2001, p 1.

[15] Converse, J. Correspondence of August 12, 1988, to Jim Baker, relating to the installation of a Multi-Flo unit serving a residence at the Poultry Farm at the University of Wisconsin Experimental Farm in Arlington, WI

[16] Burks, B. "Aerobic Wastewater Treatment Units." Memorandum to Private Sewage Staff and County Code Administrators, 1991. Wisconsin Department of Industry, Labor and Human Relations, 201 West Washington Avenue, Madison, WI

[17] Converse, J. and Tyler E.J. "Renovating Failing Septic Tank-Soil absorption Systems Using Aerated Pretreated Effluent." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 8.24, 1994, pp 1-8.

[18] Converse, J., Converse, M., and Tyler, E.J. "Aerobically Treated Effluent for Renovating Failing Soil Absorption Units." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 10.20, 1997, p 7. Data was averaged from Table 2.

[19] In this document, the units BOD and $CBOD_5$ are used interchangeably.

[20] In this document, the units col./100 mL and cfu/100 mL are used interchangeably.

[21] Tyler, E.J. and Converse. J. "Hydraulic Loading Based Upon Wastewater Effluent Quality." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 4.40, 1989, pp 1-9.

[22] In this document, the units MPN/100 mL and cfu/100 mL are used interchangeably.

[23] Converse, J. and Tyler, E.J. "Soil Treatment of Aerobically Treated Domestic Wastewater with Emphasis on Modified Mounds." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 6.22, 1989, p 4.

[24] Personal conversation with James C. Converse, University of Wisconsin, regarding data variability, August 2000. Slight sampling errors can dramatically skew results; therefore, both median and average values are reported.

[25] Converse, J. and Tyler, E.J. "Soil Treatment of Aerobically Treated Domestic Wastewater with Emphasis on Modified Mounds." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 6.22, 1998, p 5.

[26] Ibid, p 12.

[27] Converse, J. and Tyler, E.J. "Soil Dispersal of Highly Pretreated Effluent—Considerations for Incorporation into Code." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 10.22, January 1999, p 5.

[28] Ibid, p 2

[29] Personal conversation with James C. Converse, University of Wisconsin, regarding data variability, August 2000. Slight sampling errors can dramatically skew results; therefore, both median and average values are reported.

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[30] Personal conversation with James Baker, Multi-Flo Wisconsin, regarding sampling data. Mr. Baker stated that improper siting directly resulted in cross contamination, which skewed the average value for fecal coliform. He cites the "Woods System," which was sited in proximity to a horse paddock. Runoff from this paddock, Mr. Baker observed, flowed directly to an and around the Multi-Flo unit.

[31] Publication 10.22, page 6, makes reference to a Burks and Baldwin memorandum wherein the State of Wisconsin allows a 24-inch separation distance from a limiting factor when an aerobic treatment unit is used. This author was a co-author of that memorandum. The decision on a 24-inch separation distance was made for political—not technical—reasons. The technical recommendation was to allow a 12-inch separation distance, as indicated by the result and ongoing discussions with the Drs. Converse and Tyler. The revised Comm 83, which governs onsite wastewater treatment system design, has since superceded the memorandum.

[32] Converse, J. and Tyler, E.J. "Soil Dispersal Units with Emphasis on Aerobically Treated Domestic Effluent." Madison: University of Wisconsin, Small Scale Waste Management Project, Publication 16.4, Revised, January 1999, pp 1-20.

[33] Bohrer, R. and Converse, J. "Soil Treatment Performance and Cold Weather Operations of Drip Distribution Systems." *Onsite Wastewater Treatment: Proceedings of the Ninth National Symposium on Individual and Small Community Sewage Systems.* St. Joseph: American Society of Agricultural Engineers, March 2001, p 567.

[34] Coliphages are viruses that infect coliform bacteria. Coliphage presence can confirm the presence of fecal contamination even when fecal and total coliform tests are negative. Coliphages are also better indicators of enterovirus.

[35] Cliver, D. Correspondence from University of Wisconsin, Food Research Institute, dated October, 26, 1993, to Jim Baker and relating to coliphage removal at the Mandt Farm.

[36] These values are a result of combining data from Schirmers and Weller, as noted below.

[37] Schirmers, S. Personal Conservation and Summary Reports from Midwest Analytical Services, December 10 and 18, 2001.

[38] Weller, R. Personal Conservation and Summary Report from Midwest Analytical Services, October 26, 2001.

[39] Personal conversation with Jim Converse. While data support both reduced separation distances and higher hydraulic loading rates, Converse recommends doing one or the other but not both.

[40] Pancabo, O. Correspondence, from East Tennessee State University, dated June 5, 1984, to Bob Parker, regarding poliovirus removal during a field study of a Multi-Flo unit.

[41] Amsbarry, R. "Results of Multi-Flow (sic) Effluent Sampling, Private Sewage Code." Memorandum dated January 12, 1981, Illinois Department of Public Health, Division of Engineering, Champaign, IL

[42] Lee County Health Department. "Test Results from Multi Flo Units Installed in Lee County." Undated, unsigned summary.

[43] Multi-Flo Waste Treatment Systems, Inc. "Multi-Flo Field Testing Program." Undated, unsigned memorandum summarizing monitoring results.

[44] Burgess, E. Correspondence from Mid-Ohio Valley Health Department, dated April 18, 1988, to Bob Parker, regarding Multi-Flo Performance.

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[45] "Wastewater Sampling Assessment, Island County Special On-Site Demonstration Grant Program." Island County Health Department, Post Office Box 5000, Coupeville, WA, 98239, August 1999