TOTAL SUSPENDED SOLIDS AND OIL & GREASE REMOVAL BY A GREASE-TRAP EFFLUENT FILTER

Project Report

by

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INTRODUCTION

Restaurant discharges into public sewers have been a problem for many years, but have become a greater problem with the large number of full service and fast food restaurants being built both in large cities and rural communities across the country. These restaurants typically discharge large amounts of suspended solids (SS) and oil & grease (O&G) that will reduce the capacity of public sewers over time.

The traditional treatment for this waste prior to discharge into the public sewer is a grease-trap that causes separation of the floatable and settleable materials. The discharge from a grease-trap comes from the clear-zone created by this separation process. Even though it is called a clear-zone, the water from this zone still usually includes a considerable amount of relatively low specific gravity SS and high specific gravity O&G.

Recently, the application of grease-trap effluent filters was evaluated as a possible addition to the treatment of this clear-zone waste. A study performed in Sydney, Australia, on a 40-seat café indicated that the discharge from the restaurant cooking area had an average suspended solids and oil & grease of 3,024 and 3,630 mg/L, respectively. Using a grease-trap effluent filter (A-300 produced by Zabel Environmental Technology) to improve treatment, the average suspended solids was reduced to 84 mg/L and the average effluent O&G 78 mg/L [1]. The combination of the grease-trap and the effluent filter resulted in an average 78 percent reduction in SS and 84 percent reduction in O&G. Another study performed in Australia concluded that the effect of this same grease-trap effluent filter was a reduction in the SS of 61 percent and O&G of 63 percent [2].

These studies indicated the need for improved treatment of grease-trap effluents and also suggested that an effluent filter may be one inexpensive option for the treatment. Zable Environmental Technology contacted Tennessee Technological University to produce additional non-biased data on the effect of the Zabel A-300 grease-trap effluent filter unit.

Objectives

This project was conducted at Tennessee Technological University to produce additional data on a commercial grease-trap effluent filter (A300 produced by Zable Environmental Technology). The main goal of this project was to evaluate the effect of this effluent filter on the quality (SS and O&G) of the effluent discharged from the clear-zone of a restaurant grease-trap. This goal was to be achieved by the following steps.

1. Determine the percent reduction in SS and O&G in the effluent from the clear-zone with the filter unit installed.
2. Determine the percent reduction in the SS and O&G in the effluent from the clear-zone with only a standard tee installed.
3. Use steps 2 and 3 to establish the net effect due to the filter unit installation.

This current report gives the results from Step 1. The results of Steps 2 and 3 will be forthcoming.

In-Tank Effluent Filter Installation

The Zable Multiple-Purpose Filter is designed to reduce the suspended solids and oil & grease component of the tank effluent. The exterior of this filter consists of a cylindrical plastic housing 16 inches high and 12 inches in diameter with a 4-inch PVC coupling. Sheets of plastic in the form of plates comprise the removable interior of the filter. There are 27 individual plates stacked on top of each other with built-in spacers that force the water through a 1/32-inch opening. A diagram of the Zable Multiple-Purpose Filter and its material specifications is shown in Figure 1. Its installation in a typical grease trap is shown in Figure 2.

Theoretically, the Zable filter operation might be similar to a tube or plate settler. Tube and plate settlers are constructed to increase the efficiency of suspended solids removal in a sedimentation basin. The water movement through the device encourages laminar flow, and consequently the deposit of solids on its surfaces. The plates or tubes permit the solids to settle to the bottom in a short period of time and distance. Once the particle comes into contact with the plate or tube it is effectively removed [3].

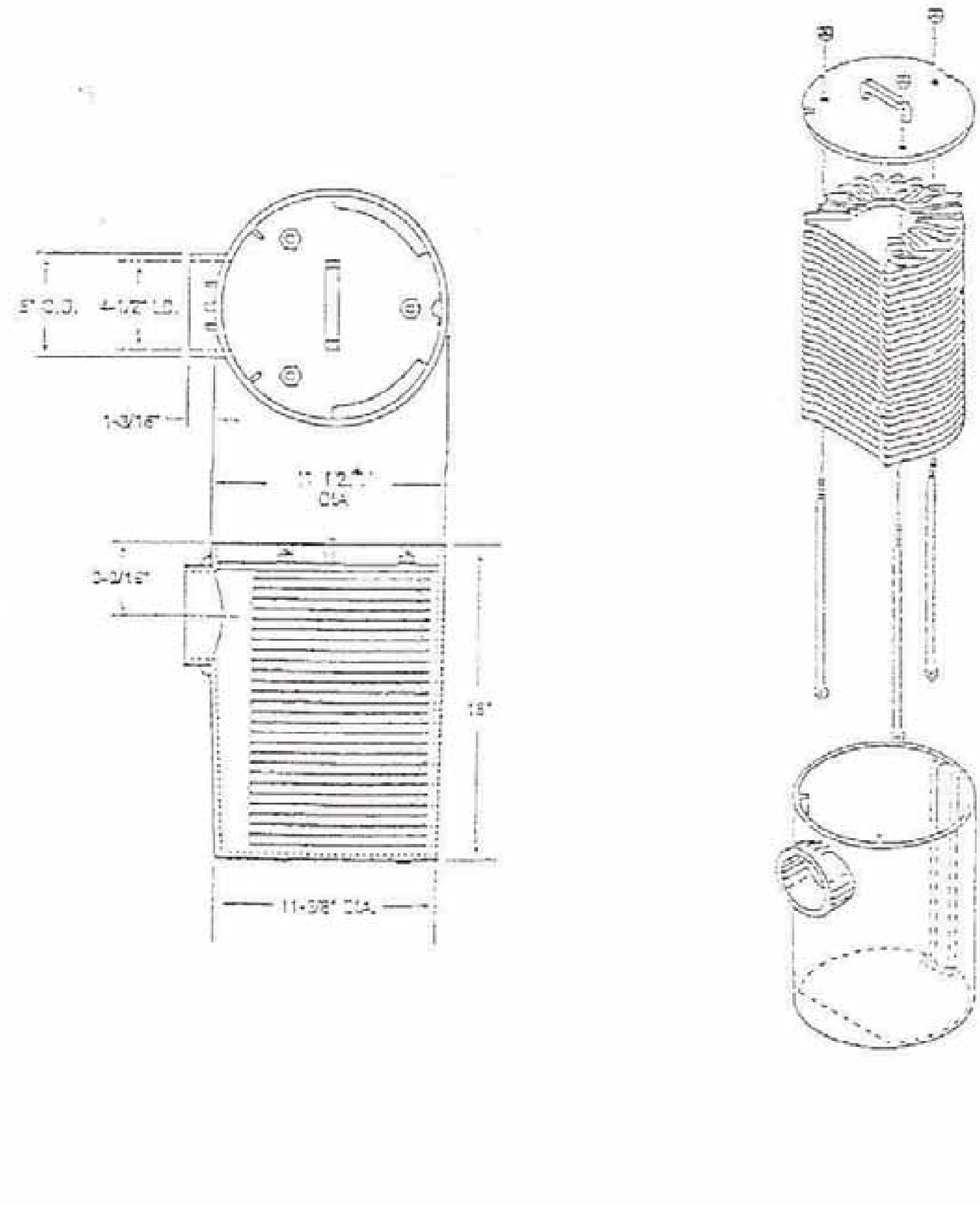


Figure 1. Zabie Multiple-Purpose Filter [4].

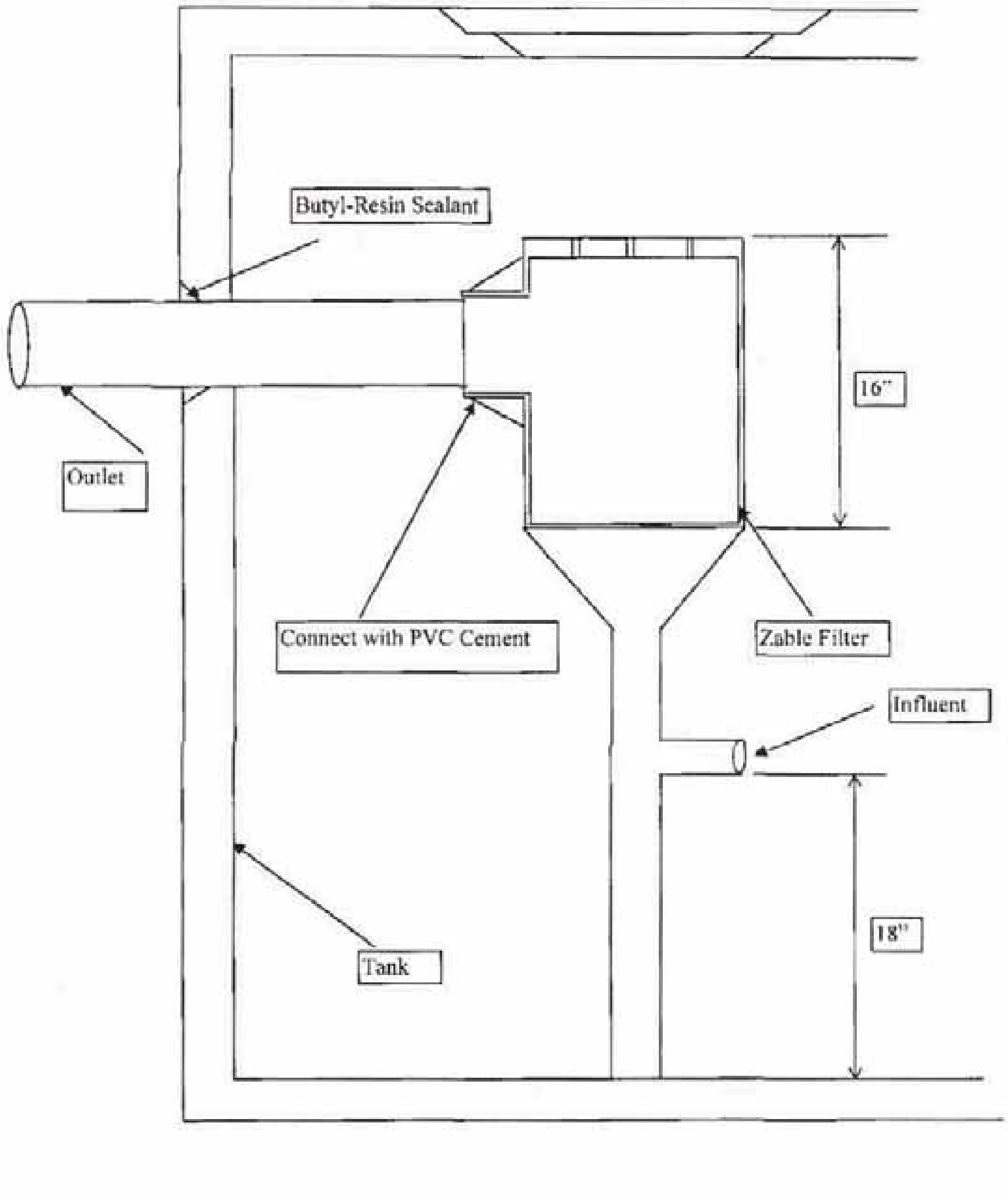


Figure 2. Zable Multiple-Purpose Filter Installation

Site Location and Description

The sampling sites were four full service restaurants in Cookeville, Tennessee. The grease traps were different in size, dimensions, and volume. Restaurant #1 had a grease-trap (volume approximately 1000 gal.) with two baffle walls producing a three-compartment unit. Restaurant #2 grease-trap (volume approximately 2000 gal.) had baffles that isolated the influent and effluent. Restaurant #3 grease-trap (volume approximately 2300 gal.) had a wall producing an effluent compartment, and Restaurant #4 (volume approximately 5400 gal.) was a rectangular tank with no compartment or baffle. Specific information related to the operation of the restaurants is given in Table1.

Table 1. Restaurant Operating Information

Restaurant	Seats	Daily Meals	Cooking Oil & Grease	Additives to Clean Drains	Monthly Water Usage (gal)	Frequency Of Cleaning Kitchen	Dish Washing Temp. °F	Washing System
#1	260	400	Vegetable	None	107833	2/day	140	Oasis
#2	150	500	Vegetable	None	83250	2/day	175 to 200	***
#3	250	350	Vegetable	None	80500	2/day	160 to 180	Suremix
#4	396	***	Vegetable	Bleach	205333	2/day	160 to 180	Oasis

*** Information Not Given by Restaurant

Sampling Schedule

Two samples were taken from the grease-traps each day, one sample from the clear-zone at the inlet to the filter base (influent) and one sample at the outlet from the top of the filter unit (effluent). During the week a composite of the samples for each site was prepared. These composite samples were used for the Total Suspended Solid (TSS) and the Oil & Grease (O&G) analysis. Sampling started on May 12, 1997, and ended on July 6, 1997.

All samples were taken in the morning hours between 6:30 A.M. and 10:00 A.M. The samples were collected from each site in the same order during each sampling trip, and the sampling procedure was consistent throughout the study.

The sample at the effluent from the filter was taken first and then the sample at the influent from the clear-zone. The samples were placed into glass bottles and transported back to the lab. The filter influent samples were collected with a specially constructed sampling device that was put back in place after a day's sampling at each restaurant. This procedure produced an un-disturbed sample taken on the following day.

The pH and temperature of the samples in the grease trap were recorded during each sampling trip. An ATI Orion Portable Meter Model 290A was used to measure the pH and temperature simultaneously, after the sample had been placed in the sampling bottle. All laboratory testing was performed in accordance with the methods set forth in *Standard Methods for the Examination of Water and Wastewater* [5].

After each sampling trip, a 100ml volume of each sample was poured into a bottle to prepare the weekly Total Suspended Solids composite sample. The composite samples were placed in a refrigerator at 4 °C daily. After 7 days of composite sample preparation, the composite samples were used for the Total Suspended Solids determinations.

A 250ml volume of sample from each site was poured into a ½ gallon bottle and placed in a refrigerator at 4°C daily. Approximately 2 to 3ml of saturated sulfuric acid (H_2SO_4) were added the samples. After seven days the composite samples were used for the Oil & Grease analyses. The Oil & Grease analyses were run by the Center for the Management, Utilization and Protection of Water Resources located at Tennessee Technological University. A more detailed description of the Oil & Grease procedure can be found in the Standard Methods Section 5520 [5].

Results

Temperature and pH

There was no significant difference between the pH and temperatures of the influent and effluent samples during the project. Restaurant #1 samples had a pH of 4 (SD= 0.24) and a temperature of 33.5° C (SD=2.0). Restaurant #2 samples had a pH of 5.23 (SD=0.29) and a temperature of 28.2° C (SD=1.73). Restaurant #3 samples had a pH of 4.71 (SD=0.27) and a temperature of 32.8° C (SD=2.97). The samples of Restaurant #4 had a pH of 4.12 (SD=0.36) and a temperature of 39.9°C (SD =1.38).

Suspended Solids and Oil & Grease

The SS data are presented in Table 2 and the O&G data in Table 3. As indicated in the tables, the percent reductions of the SS across the Zabel A-300 were 55.6, 46.8, 56.7, and 26.8 percent for Restaurants 1, 2, 3, and 4, respectively. The percent reductions in the O&G across the filters were 51.7, 46.8, 50.1, and 43.5 percent for Restaurants 1, 2, 3, and 4, respectively.

Discussion of Results

Since the pH and the temperatures did not vary significantly during the project, these parameters probably did not have a significant effect on the variations in the SS and O&G results. The temperature could have affected the composite averages during the project for each site by affecting the amount of O&G that was in solution and the size of the SS present. Restaurant #4 had a lower percent reduction in both O&G and SS, and a higher temperature. Comparisons cannot be made between the different restaurants due to the differences in the tanks, but as indicated in the following Figure 3 and Figure 4, there does seem to be a trend relating reduction in percent removal and increase in temperature. The effect on the reduction in the O&G was also probably related to the reduction in the removal of SS. The O&G in the effluent samples did generally vary directly with the SS that remained in the effluent samples.

The reduction in O&G and SS need to be considered separately for each restaurant, due to the significant differences in the grease-traps and the operation of the restaurants. The reductions in SS ranged from 26.8% to 56.7%, and the reductions in O&G from 43.5% to 51.7%. Future studies will need to be conducted to determine the specific mechanisms causing these reductions.

Table 2. **Total Suspended Solids (mg/L)**

Restaurant	#1			#2		
Week	Influent	Effluent	%Removal	Influent	Effluent	%Removal
1	1994.67	853.33	57.22	830.67	416.00	49.92
2	1680.00	874.67	47.94	704.00	412.00	41.48
3	1016.00	733.33	27.82	568.00	436.00	23.24
4	2008.00	678.67	66.20	796.00	370.67	53.43
5	3172.00	748.00	76.42	694.00	356.00	48.70
6	1874.00	750.00	59.98	396.00	266.00	32.83
7	1622.00	698.00	56.97	412.00	176.00	57.28
8	1536.00	740.00	51.82	560.00	180.00	67.86
St. Dev.	***617.4***	***69.4***		***163.7***	***105.5***	
Average			***55.55***			***46.84***

Restaurant	#3			#4		
Week	Influent	Effluent	%Removal	Influent	Effluent	%Removal
1	613.33	304.00	50.43	558.67	370.67	33.65
2	725.33	216.00	70.22	508.00	481.33	5.25
3	638.67	200.00	68.68	378.67	428.00	-13.03
4	538.67	276.00	48.76	856.00	404.00	52.80
5	418.00	224.00	46.41	436.00	438.00	-0.46
6	382.00	198.00	48.17	478.00	438.00	8.37
7	614.00	188.00	69.38	962.00	456.00	52.60
8	454.00	220.00	51.54	1872.00	470.00	74.89
St. Dev.	***120.5***	***40.7***		***495.8***	***35.8***	
Average			***56.70***			***26.76***

Table 3. **Oil & Grease (mg/L)**

Restaurant	#1			#2		
Week	Influent	Effluent	%Removal	Influent	Effluent	%Removal
1	908	418.0	53.96	317.0	191.0	39.75
2	1130	698.0	38.23	457.0	290.0	36.54
3	431	323.0	25.06	284.0	106.0	62.68
4	532	277.0	47.93	306.0	186.0	39.22
5	976	215.0	77.97	136.0	76.0	44.12
6	777	251.0	67.70	212.0	97.0	54.25
7	549	246.0	55.19	246.0	125.0	49.19
8	408	214.0	47.55	107.0	55.0	48.60
St. Dev.	***271.9***	***163.0***		***110.8***	***77.2***	
Average			***51.70***			***46.79***

Restaurant	#3			#4		
Week	Influent	Effluent	%Removal	Influent	Effluent	%Removal
1	141.0	71.3	49.43	269.0	132.0	50.93
2	216.0	105.0	51.39	322.0	189.0	41.30
3	148.0	76.0	48.65	345.0	172.0	50.14
4	168.0	92.0	45.24	283.0	148.0	47.70
5	99.0	47.0	52.53	163.0	131.0	19.63
6	123.0	64.0	47.97	210.0	149.0	29.05
7	101.0	43.0	57.43	124.0	48.0	61.29
8	111.0	58.0	47.75	326.0	170.0	47.85
St. Dev.	***39.5***	***21.3***		***81.3***	***43.2***	
Average			***50.05***			***43.49***

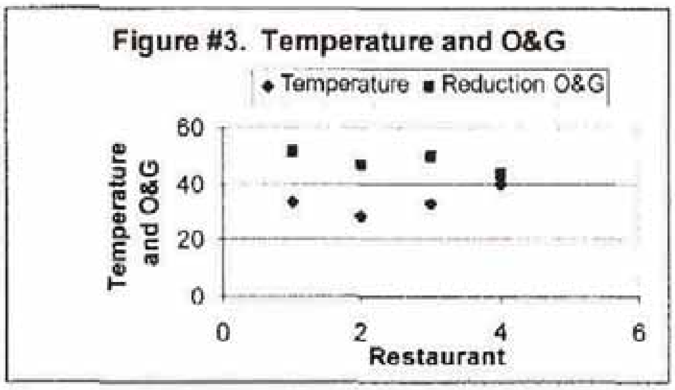


Figure #3. Temperature and O&G
Temperature
Reduction O&G
Temperature and O&G
60
40
20
0
0
2
4
6
Restaurant

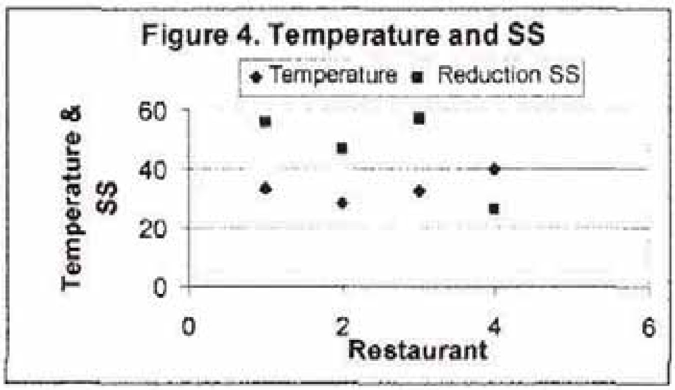


Figure 4. Temperature and SS
Temperature
Reduction SS
Temperature & SS
60
40
20
0
0
2
4
6
Restaurant

References

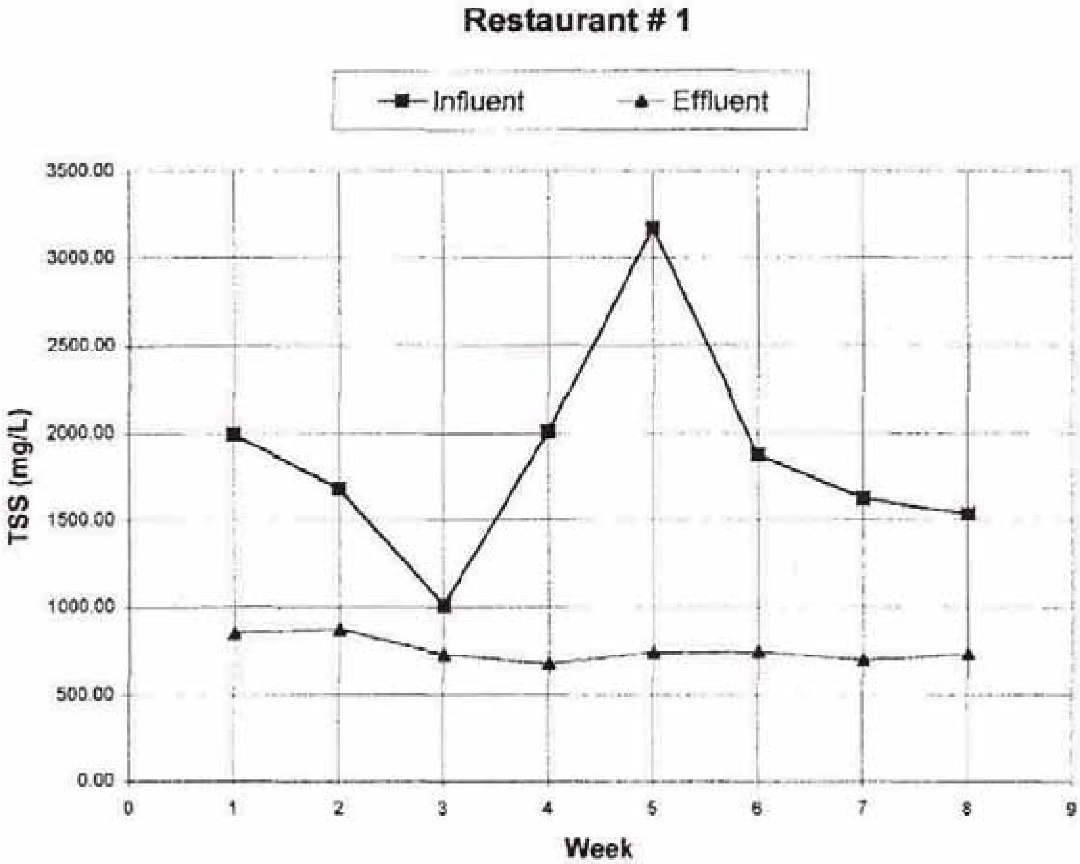
1. *Ecotec Grease Extractor of Berry Cafe North Sydney*, Taylex Queensland Pty. Ltd. 1996.

2. Grease Traps Studies on Total Suspended Solids and Oil & Grease in Perth (Western Australia) by Taylex Queensland Pty. Ltd., May 1997.

3. Montgomery, James M, *Water Treatment Principles and Design*, John Wiley and Sons, New York, NY, 1985.

4. *An Extended Study of The Treatment Capability of Three In-Tank Filters for Septic Tank Effluent*, Stewart 1997.

5. American Public Health Association, American Water Works Association, and Water Environment Association. *Standard Methods for the Examination of Water and Wastewater*. 18^{th} Edition. American Public Health Association, Washington, DC, 1992.



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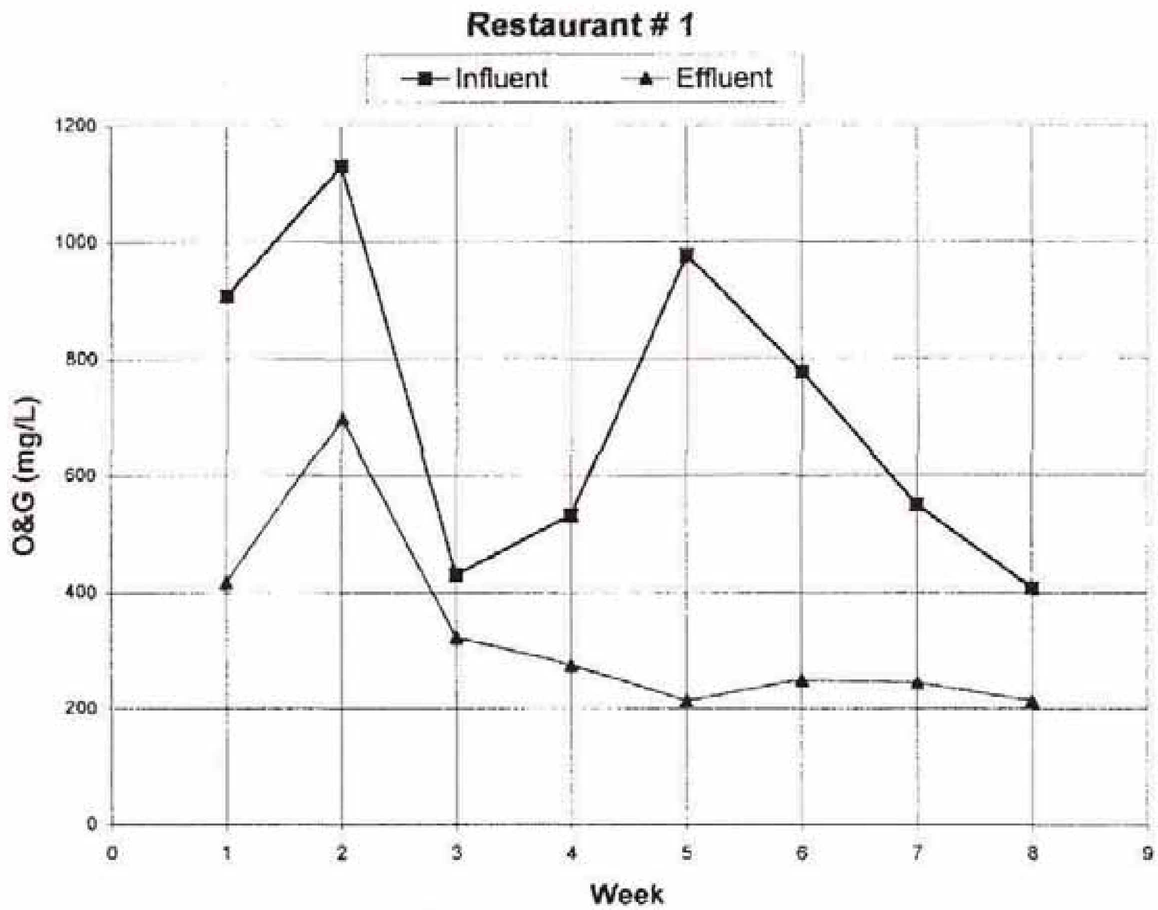
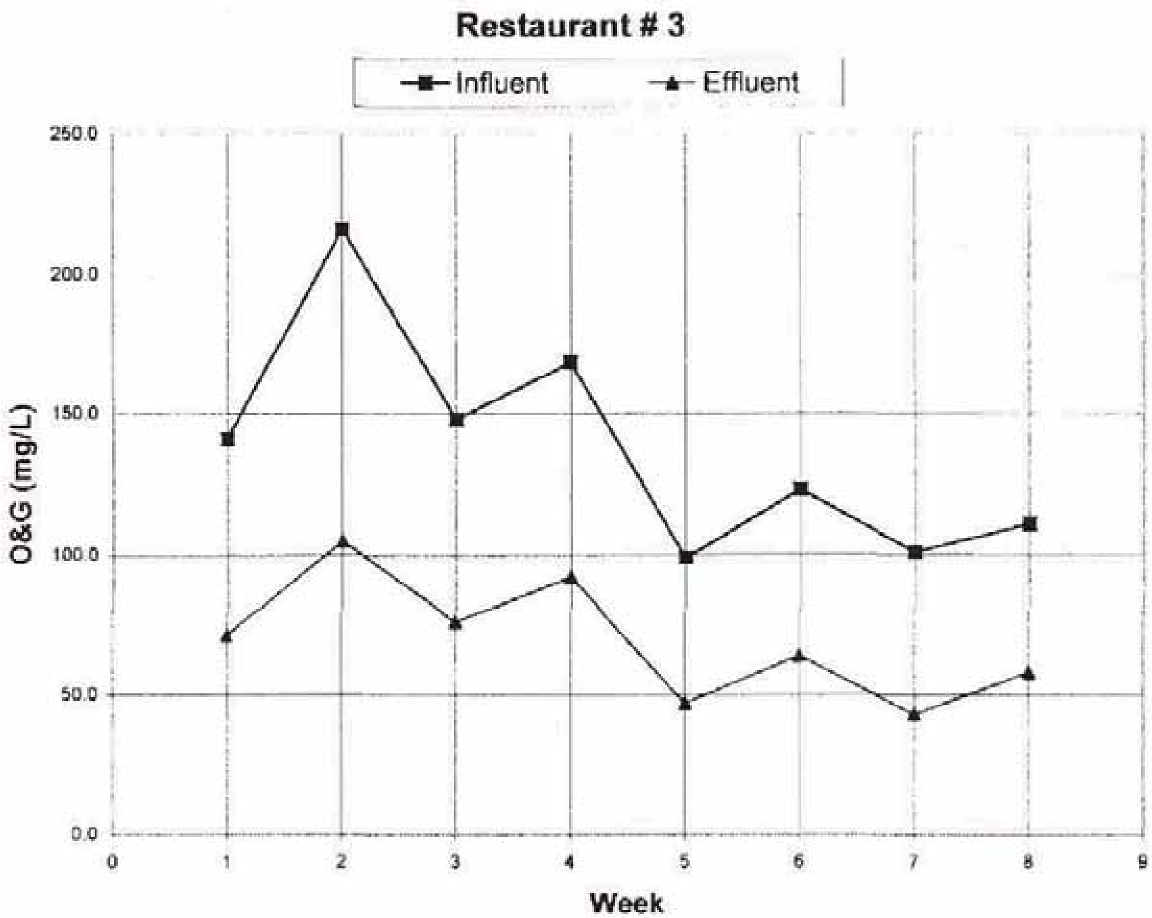

Restaurant # 1
Influent
Effluent
O&G (mg/L)
Week
0
200
400
600
800
1000
1200
0
1
2
3
4
5
6
7
8
9

Restaurant # 2
Influent
Effluent
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
TSS (mg/L)
0
1
2
3
4
5
6
7
8
9
Week

greasest.MAX


Restaurant # 3
Influent
Effluent
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
TSS (mg/L)
0
1
2
3
4
5
6
7
8
9
Week



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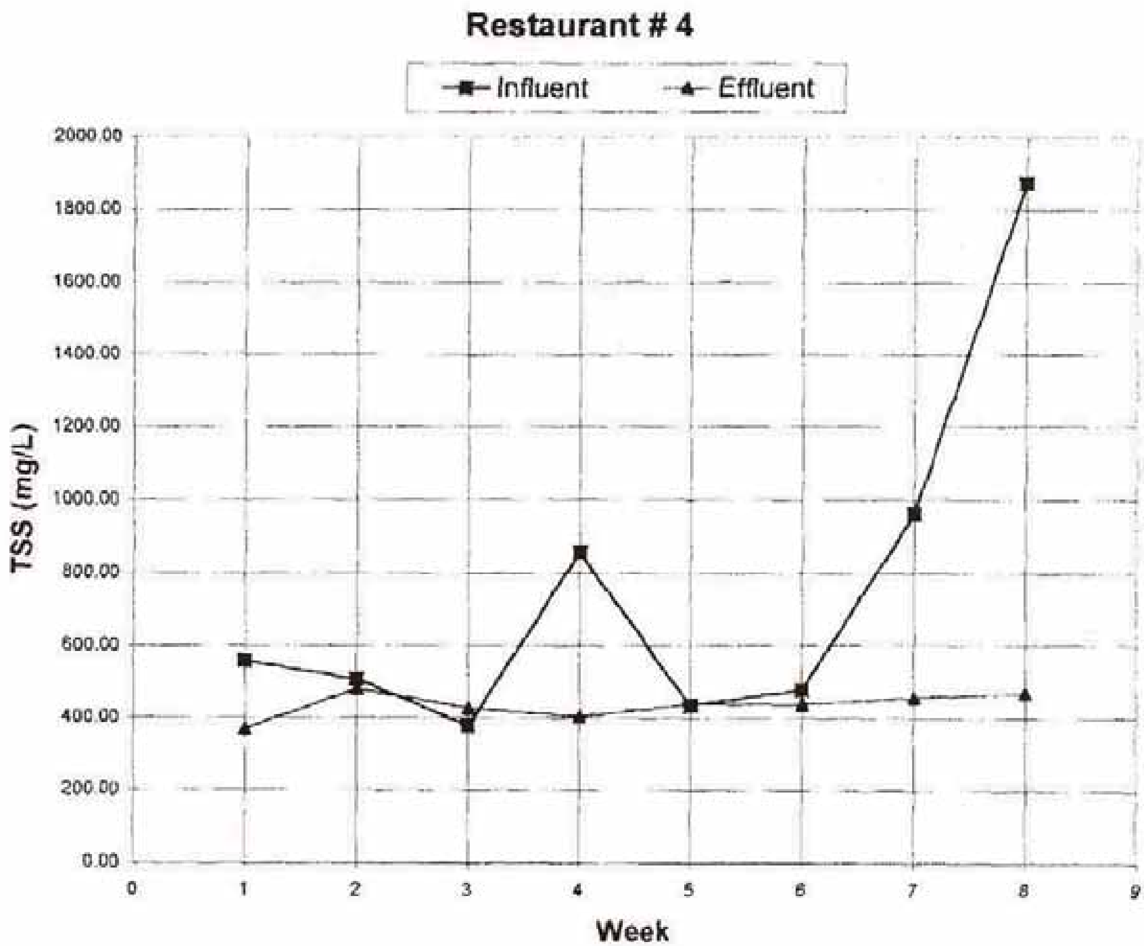

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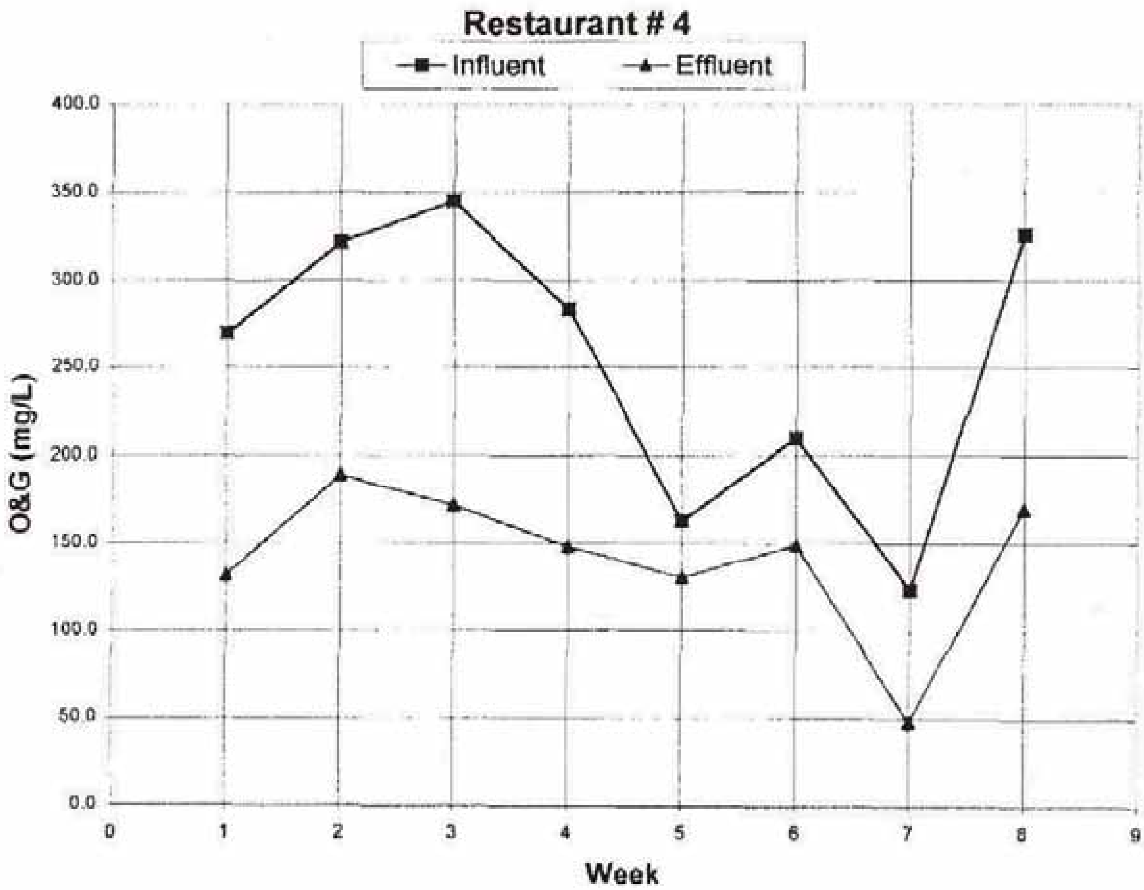

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Zabel Filter Test Reports

Most university, government and independent testing laboratories report TSS and BOD as an average of the data points taken before and after filtration. Zabel has also developed a new device for taking a control sample as well as a filtered sample at the same time in order to directly compare and report the results as an average percentage of reduction. Both methods are based on a technique for comparing filtered and non-filtered effluent from the same septic source.

Reporting TSS from a filtered source without comparing an unfiltered sample from the same source tells nothing about the actual contribution the filter made to the performance of the system. For example, you can report an average TSS of 30ppm, but without knowing what the TSS was before the filter was installed you can't tell whether the filter performed well or not.

Because of the way others have reported their filter's "performance", Zabel has always reported our filters performance including the benefit of the septic tank itself. If the tank removed 31% of the TSS and Zabel's filter improved this by 68%, the total system - tank and filter - were removing 98% of the total solids.

Consistent with university, government and independent testing laboratories we will continue to report the filtered versus unfiltered effluent from the same site as a percentage of improvement, but we will only report the actual improvement achieved by the filter ignoring the performance of the tank. We recommend our competitors do the same so it will be easier for the industry to compare results.

Keep this in mind when you compare the following test results with our competitors or with our previous reporting method.

Data Point Averages	TSS **Before**	TSS **After**	% Reduced	BOD$_5$ **Before**	BOD$_5$ **After**	% Reduced
Zabel A100						
TN Tech University	95.7	45.8	52.1	131.3	89.3	31.9
Kentucky Testing Laboratory	93.2	31.0	66.7			
Zabel A300						
Wastewater Services[1]	6530	113	98.3	2130	780	63.4
Zabel A1800						
DNREC, Div. of Water Resources	190.5	68.0	64.3			
Zabel Proprietary Test Program	131.6	56.6	56.9			

1. The grease & oils for this installation were: Before - 1764 After - 2.2 % Reduced - 99.8

In addition to the data shown above, Zabel received a report on five restaurants monitored by the Merrillville Conservancy District. This report was done by ranges and is shown below.

Zabel A300	Range mg/l Without Filter	Range mg/l With Filter	% Reduction Low End	% Reduction High End
Kentucky Fried Chicken	120 to 6500	50 to 110	53.3	98.3
New Moon Chinese	76 to 1300	34 to 120	55.3	90.8
Cisco's Mexican	96 to 1040	19 to 110	80.2	89.4
Gary Country Club	130 to 706	22 to 94	83.1	86.7
Patio Restaurant	70 to 800	50 to 120	28.6	85.0