WASTE STABILIZATION PONDS: POSSIBLE CONTAMINATION OF THE SHORE

by

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Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute
in candidacy for the degree of
MASTER OF SCIENCE
in
Sanitary Engineering

August 1963

Blacksburg, Virginia

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I. INTRODUCTION

Waste stabilization ponds are becoming widespread as a means of treating sewage and some industrial wastes. They provide an economical method of treatment where there is enough inexpensive land. Also the amount of supervision and upkeep required is minimal. Waste stabilization ponds have proven to be an adequate means of treatment comparable in many ways to conventional methods of treatment. These ponds also effect a substantial reduction in the number of coliform organisms which are employed by public health agencies as indicators of fecal contamination.

One aspect of waste stabilization ponds which has not been investigated is the possibility of a health hazard due to accumulation of floating solids at the shore line. If such solids were of fecal origins they could be conveyed by flies or other vectors to adjacent communities with the possibility of the transmission of enteric disease.

The purpose of this study was to check for the presence of contamination around the shore of domestic waste stabilization ponds. Counts were made of the number of coliform organisms and enterococci present at the shore line to detect the presence of contamination. These counts were compared with counts made from water in the pond and from soil adjacent to the shore line. The series of samples listed above was taken at three stations along the length of the leeward side of the pond. The condition of the pond in regard to floating matter was also considered. The number of coliforms present at the different sampling points was considered the principle index of the presence of contamination.

Fecal streptococci are coming into use as indicators of pollution, so it was considered of value to use them for comparison with the coliforms. There are three principal reasons for the interest developing in the use of fecal streptococci as indicator organisms for fecal contamination. Firstly, the coliform test includes organisms of both fecal and non-fecal origin, and it is a complicated laboratory procedure to differentiate them. Secondly, the different types of fecal streptococci may possibly be used to determine if the fecal contamination is of human or non-human origin. Thirdly, the fecal streptococci will provide a good check on the coliform test; that is, the presence of high concentrations of both coliforms and fecal streptococci would constitute strong evidence of fecal contamination.

The conclusions drawn from the data should assist in the establishment of the status of waste stabilization ponds in regard to public health.

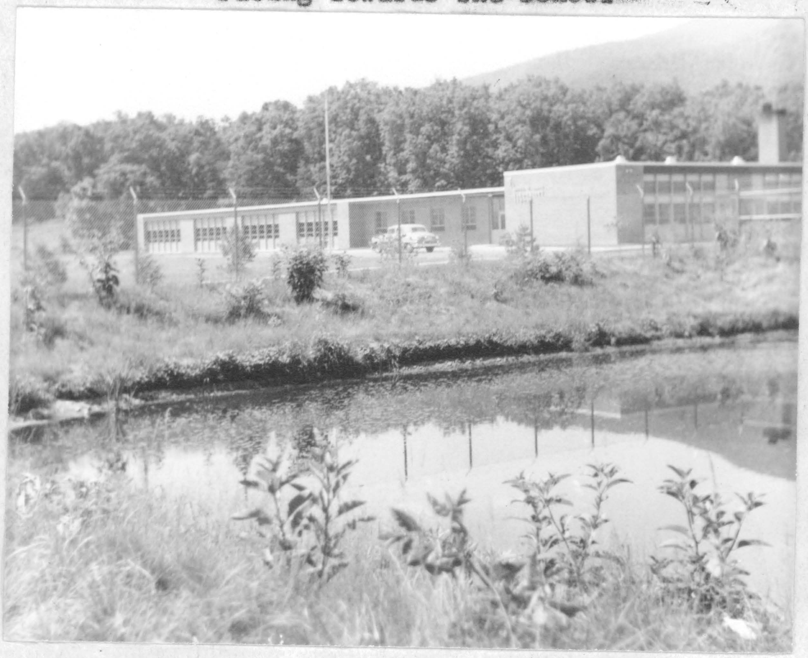
The waste stabilization pond on which the investigation was made is located at Masons Cove Elementary School in Roanoke County. (Plate 1) It provides for the treatment of

Plate 1

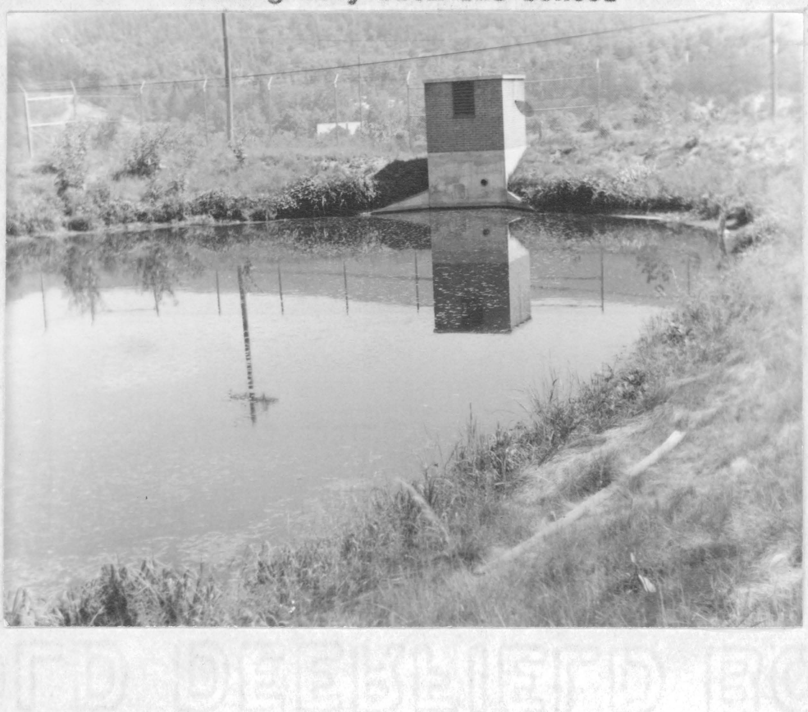
Views of the Waste Stabilization Pond,

Masons Cove Elementary School

Facing Towards The School



Facing Away From The School



sewage from the school. The population served is approximately 325 elementary school children and staff.

The pond is 80 x 110 feet with a surface area of 8,800 square feet. The basic design criterian specified by the State of Virginia is 400 persons per acre (1). Ten elementary school children are considered equal to one person. The design capacity equals 400 x 10 x 8,800/43,560 = 806 elementary school children. At the present time the inflow is not sufficient to fill the pond to more than two or three feet. If and when the pond fills to design depth a chlorinator has been installed to chlorinate the overflow. The design depth is five feet. There were no odor or other problems associated with the operation of the pond.

II. LITERATURE REVIEW

A review of the literature did not disclose any direct reference to the contamination of the shore line of waste stabilization ponds. Reference was made by Ellison and Smith (3) to the possibility of contamination being spread by animals which have access to the pond. This would imply that the shore was contaminated. But there is no suggestion of the possibility of the contamination of the shore by floating matter.

If the shore is or is not contaminated by floating matter the shore would be contaminated to the extent that the water was contaminated. There has been some research on the level of coliform concentration in stabilization ponds. In reviewing the literature on waste stabilization ponds Fitzgerald and Rohlich (4) stated that "in nearly all instances the bacterial counts have been lowered to less than one per cent of the original concentration. The E. coli counts have generally been reduced from several hundred thousand to less than 100 per ml. and one case has been reported where typhoid bacteria were reduced from 41 per ml. to negative results."

Mackenthun and McNabb (7) note in studying waste stabilization ponds in Wisconsin that more than 98 per cent removal of coliforms was obtained 87 per cent of the time. Optimum reduction of coliforms was observed in the summer.

These results might possibly be an indication of the importance of competition in the removal of coliforms and pathogenic organisms. The ponds are evidently much more active biologically in the summer.

Parker (12) working with ponds in Australia states that "it would appear to be difficult to obtain very low coliform counts using single cell aerobic ponds." Parker also noted that reduction in coliform counts proceeds in accordance with increased detention time and decreased BOD levels.

Oswald (11) noted that with the present variations in the number of coliform organisms removed there is need for research to correlate coliform removal with loading and design factors. Also it is the opinion of the writer that the climatic conditions which affect the biology of the pond warrant consideration.

The primary factors which contribute to the removal of coliforms and other bacteria are settling and competition. The high pH levels which are reached during the day time appear to reduce the number of coliform organisms.

Enterococci are normal inhabitants of human feces but have not until recently gained acceptance as worthwhile indicator organisms primarily because there has not been a differential medium with adequate recovery. Litsky, Mallmann and Fifield (6) developed a medium which provided adequate recovery and the organisms isolated were those of the enterococcus group.

As new media have been developed streptococci of fecal origin other than those in the enterococcus group have been recovered. Kabler (2) recommends that the enterococci and other streptococci which are used as indicators of fecal pollution be designated as fecal streptococci. In this thesis enterococci will be used to designate the organisms isolated with the medium designed by Litsky, Mallmann and Fifield (6) and also listed in "Standard Methods" (14).

Sullivan et. al. (15) observed that streptococci occurred in the feces of man and certain animals and in polluted water and sewage in numbers equal to or greater than the numbers of coliform bacteria.

"Guthof and Dammann (2) observed comparable streptococcus and coli titers in water samples from springs and from the Rhine River." In the examination of soil samples from areas where contamination was improbable or non-existent Medrek and Litsky (9) found that there were comparable numbers of enterococci and E. coli but with a much greater distribution of coliforms. Both Guthof and Dammann (2) and Medrek and Litsky (9) recommend the use of fecal streptococci as an index of fecal pollution.

In a study by Mallmann and Litsky (8) of the survival of E. coli and enterococci in different soils, enterococci died out within 40 days with a large number of E. coli remaining. Kjellander (2) observed that in sewage diluted with well water and river water E. coli showed a greater rate of decrease than fecal streptococci. Coliforms decreased at approximately the same rate as fecal streptococci. Keller (2) observed that fecal streptococci survived longer in rivers than E. coli.

Mundt (10) found enterococci in 34 of 102 samples taken in nine different agricultural fields with different crops. The number of enterococci ranged from 10 - 100 per gram of dry solids in the positive samples.

III. METHODS AND PROCEDURES

Samples were taken at three stations along one side of the pond. The side was chosen because prevailing winds blow towards it. At each station five samples were taken. These samples were taken along a line approximately perpendicular to the shore line.

The series of five samples was taken over a period of about a month. Each time a series of samples was taken the cloud condition, wind direction and temperature were recorded.

The locations at which the samples were taken are as follows:

Point 1 - A soil sample was taken from the bank at a point located five to ten feet upslope from the shore line.

Point 2 - A soil sample was taken just under the water at the shore line. It would have been preferable to take the sample right at the water line but this was not practical because of the grass shore line.

Point 3 - A water sample was taken of the surface water at the shore line.

Point 4 - A water sample was taken of surface water approximately eight feet from the shore line towards the center of the pond.

Point 5 - A water sample was taken about eight feet from the shore line and approximately one and one-half feet beneath the water surface.

The following was the procedure employed for processing the soil samples. Ten grams of sample were added to a weighed crucible. From the crucible five grams of sample was transferred into a bottle containing 100 ml of sterile buffered water (as described in "Standard Methods" (14)). The bottles also contained glass beads to help break up the chunks of soil. The bottles were shaken fifty times to suspend the organisms in the dilution water. To determine the M.P.N. three replicate tubes of serial dilution were inoculated from each bottle. The correct sequence of dilution to determine the M.P.N. was obtained by serial dilution of the sample with sterile buffered dilution water. To determine the number of coliforms lactose broth was used in the presumptive test and brilliant green lactose bile broth was used in the confirmed test. A positive test in both tests was indicated by the formation of gas after 48 hours. To determine the number of enterococci, azide dextrose broth was used in the presumptive test, a positive test being indicated by the presence of turbidity after 48 hours. Ethyl violet azide broth was used in the confirmed test, a positive test being indicated by the presence of turbidity after 48 hours and in some cases a purple bottom. All of the samples were incubated at 35°C. Procedures for the tests for coliforms and enterococci were adopted from "Standard Methods." (14)

For each of the soil samples the five grams of sample which was not put in the dilution bottle was placed in an oven overnight at 103°C for determination of the dry solids. The M.P.N.'s per gram of dry solids were determined by dividing the M.P.N.'s per gram wet weight by the fraction of dry matter. The dry sample was put in a furnace at 600°C for 20 minutes to enable determination of the ash content.

The water samples were processed as follows. The pH of each sample was determined electrometrically. Samples were analyzed to determine the number of coliforms and enterococci by the multiple tube fermentation technique using three replicate tubes for each dilution. The same media were used for the enumeration of coliforms and enterococci as were used for the soil samples.

For both the soil and water samples the M.P.N.'s for coliforms and enterococci were determined from tables in "Standard Methods." (14)

IV. RESULTS

The results of the bacteriological study of the waste stabilization pond at Masons Cove Elementary School are presented in Tables 1 through 8. The locations of the points of sampling are illustrated in Figure 1. The results of analysis of samples taken in the soil are given in Tables 2, 3 and 4. The table includes the following items: M.P.N. coliforms and M.P.N. enterococci per gram of dry solids, the percentage dry solids, the percentage ash and the run number. Tables 5, 6 and 7 give the results of the analysis of the samples taken from the water. The data presented are: M.P.N. coliforms and enterococci per ml of sample, pH, and the run number. Table 1 presents pertinent observations associated with sample collection, such as date, time, temperature, wind direction and cloud cover.

Analysis of the bacterial counts given in Tables 2 through 8 indicates that the coliform and enterococci counts are highest at Point 5. Point 5 is located approximately eight feet out in the pond at a depth of about one and one-half feet from the surface. The coliform and enterococci counts at Point 2 are generally high as compared with Points 1, 3 and 4. Counts at Point 2 are from soil samples taken at the shore line just under water.

The geometric means of the coliform counts at Points 1, 2, 3, 4 and 5 are as follows: 79.0, 583.9, 20.2, 11.5 and 1717.7.

The geometric means of the enterococci counts at Points 1, 2, 3, 4 and 5 are as follows: 32.0, 294.9, 28.4, 17.4 and 841.9.

The geometric means of the coliform counts ranked as follows going from the greatest to the least: Point 5, Point 2, Point 1, Point 3 and Point 4.

The geometric means of the enterococci counts ranked as follows going from the greatest to the least: Point 5, Point 2, Point 1, Point 3 and Point 4.

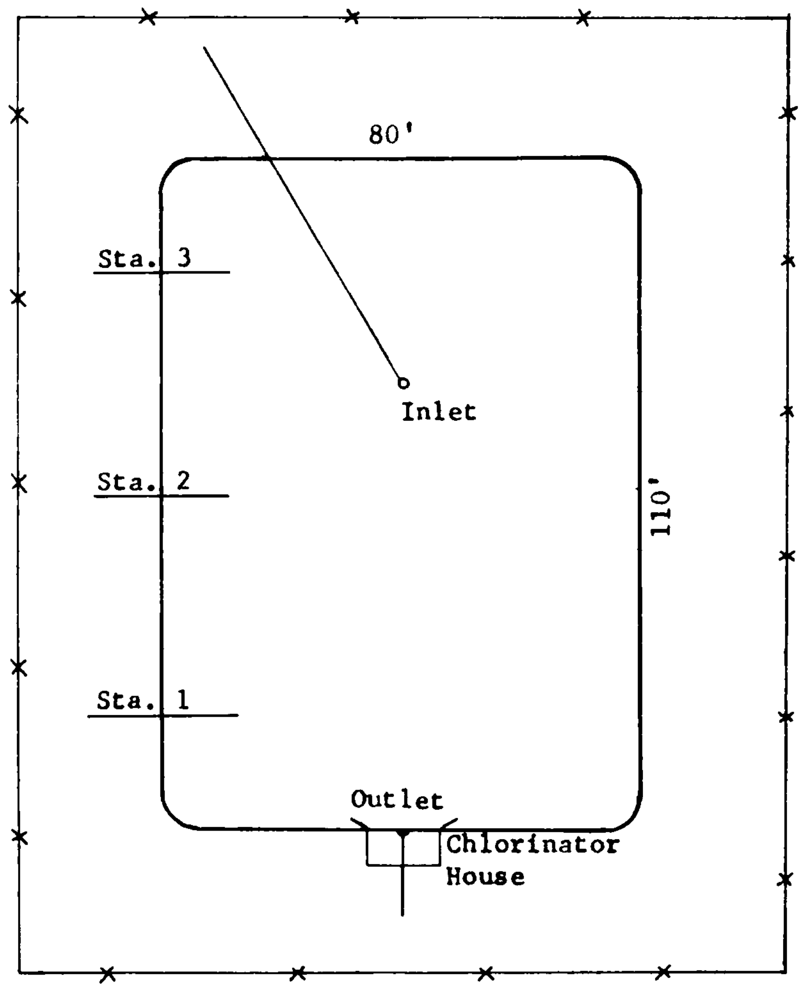
The pH values recorded at Point 5 were consistently lower than those at Points 3 and 4.

Figure 1

Sampling Points

Waste Stabilization Pond Masons Cove Elementary School

Top View



Station Cross Section

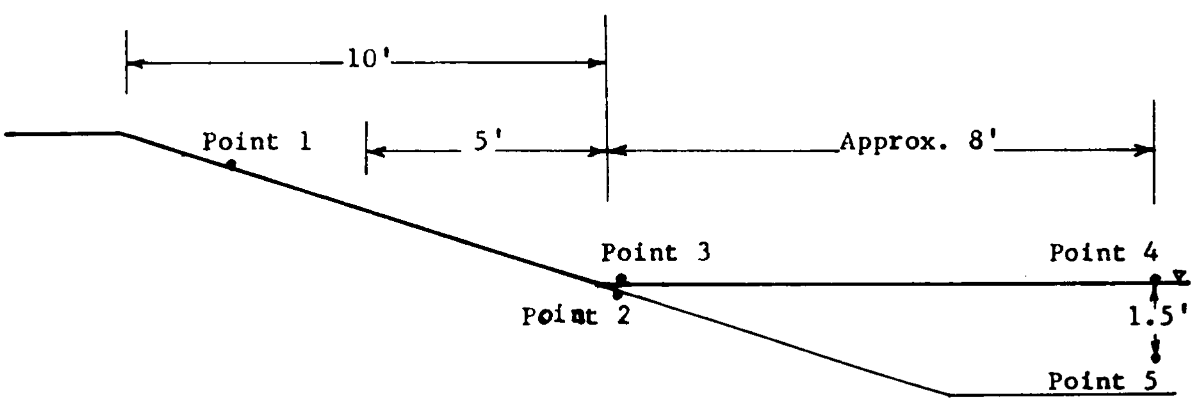


Table 1

General Data for Each Run

Run	Date 1963	Time	Wind Direction	Cloud Condition	Temp. F°
1	April 8	10:30 AM	Away from shore	Clear	61°
2	April 10	4:00 PM	Parallel to shore	Clear	53°
3	April 19	10:00 AM	Towards shore	Hazy	78°
4	April 23	2:30 PM	Towards shore	Clear	70°
5	April 25	7:00 AM	No wind	Overcast	46°

Table 2

Coliform and Enterococci Counts From Soil Samples

Station 1

	Point 1				Point 2			
Run	Coliform Count(1)	Enterococci Count (2)	% Dry Solids	% Ash	Coliform Count(1)	Enterococci Count (2)	% Dry Solids	% Ash
1	20.6	13.8	88.2	98.9	1347.0	1347.0	68.3	98.9
2	468.8	64.7	89.6	98.7	665.7	3051.3	72.1	98.9
3	7.9	0	91.3	98.8	416.1	63.8	72.1	98.9
4	7.8	32.3	92.8	98.6	3197.7	69.8	68.8	98.8
5	0	19.2	94.8	98.9	435.4	696.7	68.9	98.8

(1) Coliform count: M.P.N. per gram dry solids.
(2) Enterococci count: M.P.N. per gram dry solids.

Table 3

Coliform and Enterococci Counts From Soil Samples

Station 2

	Point 1				Point 2			
Run	Coliform Count(1)	Enterococci Count (2)	% Dry Solids	% Ash	Coliform Count (1)	Enterococci Count (2)	% Dry Solids	% Ash
1	32.5	0	92.3	98.9	60.7	197.9	75.8	99.2
2	1045.4	8.2	88.0	98.6	649.5	203.0	73.9	99.1
3	268.5	0	89.4	98.5	205.8	1262.0	72.9	99.1
4	94.3	32.9	91.2	98.2	255.1	118.0	72.9	99.1
5	165.2	77.1	90.8	98.7	427.4	31.3	70.2	99.1

(1) Coliform count: M.P.N. per gram dry solids.
(2) Enterococci count: M.P.N. per gram dry solids.

Table 4

Coliform and Enterococci Counts from Soil Samples

Station 3

	Point 1				Point 2			
Run	Coliform Count(1)	Enterococci Count (2)	% Dry Solids	% Ash	Coliform Count(1)	Enterococci Count (2)	% Dry Solids	% Ash
1	2520.0	0	87.3	98.8	1241.6	647.8	74.1	98.9
2	209.7	2480.3	88.7	98.3	3240.1	1354.9	67.9	99.0
3	334.8	5357.1	89.6	98.8	4189.9	64.2	71.6	99.0
4	7.6	254.8	94.2	98.6	96.6	64.4	74.5	99.1
5	255.6	979.8	93.9	98.6	418.4	1283.1	71.7	99.1

(1) Coliform count: M.P.N. per gram dry solids.
(2) Enterococci count: M.P.N. per gram dry solids.

Table 5

Coliform and Enterococci Counts from Pond Water Samples

Station 1

	Point 3			Point 4			Point 5		
Run	Coliform Count(1)	Enterococci Count (2)	pH	Coliform Count(1)	Enterococci Count (2)	pH	Coliform Count(1)	Enterococci Count (2)	pH
1	.9	9.3	9.4	46.0	46.0	9.3	2400.0	2400.0	8.2
2	240.0	110.0	9.6	24.0	46.0	9.7	1100.0	1100.0	8.8
3	.4	4.3	9.9	1.1	.9	9.9	460.0	1100.0	8.9
4	110.0	110.0	10.0	2.3	4.3	10.2	2400.0	460.0	8.8
5	1100.0	46.0	9.4	1100.0	75.0	9.2	2100.0	460.0	8.9

(1) Coliform count: M.P.N. per ml. of water sample.
(2) Enterococci count: M.P.N. per ml. of water sample.

Table 6

Coliform and Enterococci Counts from Pond Water Samples

Station 2

	Point 3			Point 4			Point 5		
Run	Coliform Count(1)	Enterococci Count (2)	pH	Coliform Count(1)	Enterococci Count (2)	pH	Coliform Count(1)	Enterococci Count (2)	pH
1	24.0	110.0	9.5	1.5	7.5	9.6	2400.0	2400.0	8.1
2	9.3	110.0	9.6	9.3	110.0	9.8	1100.0	1500.0	8.8
3	9.3	9.3	10.0	4.3	15.0	9.9	2400.0	1100.0	8.9
4	9.3	46.0	10.0	1.5	9.3	10.2	1100.0	460.0	8.8
5	460.0	21.0	9.2	460.0	110.0	9.1	1500.0	110.0	8.9

(1) Coliform count: M.P.N. per ml. of water sample.
(2) Enterococci count: M.P.N. per ml. of water sample.

Table 7

Coliform and Enterococci Counts from Pond Water Samples

Station 3

	Point 3			Point 4			Point 5		
Run	Coliform Count(1)	Enterococci Count (2)	pH	Coliform Count(1)	Enterococci Count (2)	pH	Coliform Count(1)	Enterococci Count (2)	pH
1	.4	9.3	9.6	.4	2.3	9.7	12.0	1100.0	8.1
2	46.0	24.0	9.7	24.0	24.0	9.8	1500.0	1100.0	8.8
3	4.3	2.3	9.8	24.0	9.3	9.4	2400.0	460.0	8.8
4	2.1	46.0	10.1	1.1	4.3	10.1	11000.0	2400.0	8.6
5	2400.0	110.0	9.1	240.0	240.0	9.1	11000.0	460.0	8.9

(1) Coliform count: M.P.N. per ml. of water sample.
(2) Enterococci count: M.P.N. per ml. of water sample.

Table 8

Summary of Counts for Each Point

Coliform

	Point 1(1)	Point 2(1)	Point 3(2)	Point 4(2)	Point 5(2)
Geometric Mean	79.0	583.9	20.2	11.5	1717.7
Median	165.2	435.4	46.0	9.3	2400.0
Arithmetic Mean	362.6	1123.0	38.0	11.6	3452.0

Enterococci

	Point 1(1)	Point 2(1)	Point 3(2)	Point 4(2)	Point 5(2)
Geometric Mean	32.0	294.9	28.4	17.4	841.9
Median	32.3	203.0	46.0	15.0	1100.0
Arithmetic Mean	621.3	697.0	49.2	23.2	1107.0

(1) M.P.N. per gram dry solids from soil samples.
(2) M.P.N. per ml. from water samples.

V. DISCUSSION

An analysis of the data from station to station for the different sample points does not show any significant trend. On the other hand, analysis of the counts at different sample points at the same station or comparable sample points at different stations indicated a definite trend from point to point.

Sample points can be divided into two areas: Soil samples taken from the bank and water samples taken from the water. Counts from the soil are in organisms per gram dry solids. Counts from the pond water are in organisms per ml. Examination of the pond water data revealed that counts at Point 5 are the highest counts in the pond and are in fact the highest overall counts obtained at any sampling point. Samples at Point 5 were taken about eight feet from the shore line towards the center of the pond and at a depth of approximately one and one-half feet from the surface. The counts at Points 3 and 4 are the lowest counts from the water and for all the samples taken. Samples for Points 3 and 4 were taken from the water at the surface of the pond.

The high counts at Point 5 are presumably the result of adding the sewage from the school to the pond. The low counts at Points 3 and 4 correspond with an increase in the pH above neutral. The pH in waste stabilization ponds fluctuates diurnally with the algae growth. The algae is dependent on light for photosynthesis with growth taking place in the zone of light penetration which extends to approximately one foot below the surface. The pH of samples taken at Point 5 is closer to neutral than samples taken at Points 3 and 4. Samples for run 5 were taken early in the morning (7:00 AM) when the pH was lower than during the day. The counts taken at points 3 and 4 (run 5) were noticeably high and in the range of the counts taken at Point 2. The close association of increased pH with lower counts and higher counts with a decrease in pH indicates that increased pH is a factor to be considered in the reduction of the counts in the surface water. Sunlight effects should be considered also in the reduction of the number of organisms in the surface water. The comparatively low counts in the surface water suggest that consideration may be warranted in the design of outlet structures so as to remove selectively surface water.

It has been suggested that the increase in pH results when a reduction in the CO_2 concentration occurs with a resulting shift in the concentration of bicarbonate and carbonate ions according to the following equations:

$$2\,HCO_3^- \rightleftharpoons CO_2 + CO_3^- + H_2O$$

$$HCO_3^- \rightleftharpoons CO_2 + OH^- \qquad (13)$$

The geometric mean count at Point 3 is higher than at Point 4. This result is what would be expected if contaminated floating matter was being blown to the water's edge. Agitation due to wave action would cause dispersion of the organisms. However, the only floating matter observed was small bits of toilet paper and there was not enough of this to form an accumulation at the shore line. Since the difference in the geometric mean counts between Points 3 and 4 is small, it was concluded that the random pieces of toilet paper had little or no effect on the count at Point 3.

Analysis of the counts at the two sampling points in the soil indicates that the counts at Point 2 are higher than at Point 1. The counts at Point 1 are not higher than would be expected from a similar area which did not have a waste stabilization pond. Tables 9 and 10 (5) are counts taken from different areas under different conditions and are shown for comparison with the counts at Point 1. In observing the condition of the bank tunnels in the grass were noted. The tunnels were probably made by field mice or some other small rodent. The rodents may contribute to the existing count by fecal droppings and possibly from contact with the water.

The count at the shore line at Point 2 is the highest for the soil samples and second only to Point 5 in magnitude.

Table 9

The Percentile Distribution of M.P.N. Values/g of Sample For 251 Soils (5)

Counts (MPN/g) in quartile grades

Soil Class	No. of Samples	Confirmed Test		
		25%	50%	75%
Arid	7	1.8	1.8	1.8
Subterranean	9	1.8	2.0	230
Submerged	14	1.8	4.5	13
Pasture	23	1.8	150	2500
Shore line	58	1.8	200	3300
Woodland	56	6.8	200	14,000
Inhabited	21	33	2600	33,000
Cultivated	35	170	3000	13,000
Polluted	28	23,000	64,000	330,000

Table 10

Coliform Counts from Four Different Sources (5)

Source of Sample	Interval between samples (days)	Count (MPN/g) Confirmed Test
Oat Field	0 16 26 17 144	4,600 700 170,000 2,200 7,900
Mountain Meadow	0 15 51 61 144	79 700 15,000 7,900 17,000
Timberland (Flynn Creek)	0 15 14 37 21 33 17 144	11 1.8 49 220 3,500 84 13,000 1.8
Timberland (Needle Branch)	0 15 14 37 21 33 17 144	7.8 4.8 4.8 7.8 4.8 70 11,000 6.8

The primary reason for the high count of the soil samples at the shore line is presumably a result of the high counts in the surface water reached during the daily periods between sunset and sunrise when the pH drops and the counts increase. The high counts at Point 3 and 5 (run 5) are an example of increased counts during lower pH levels.

No deposits of fecal matter were observed at the shore line. If there had been any deposition of fecal matter much higher counts than were observed would be expected.

A comparison of the geometric mean counts of coliform and enterococci at Points 1, 2 and 5 indicates that the coliform counts at these points are approximately twice the enterococci counts. At Points 3 and 4 the geometric mean counts of enterococci are greater than the coliform counts. The higher enterococci counts may result from relatively greater resistance to the high pH levels.

VI. SUMMARY

The investigation was carried out to determine the sanitary aspects of the shore line where floating matter may accumulate and provide a potential health hazard. Samples were taken on the bank, at the shore line, and in the pond. Coliform and enterococci counts were made from these samples to determine the extent of contamination.

The results indicated a uniform areal distribution of contamination in the pond. Increased pH associated with photosynthesis by algae corresponds to a decrease in the counts from the surface water. An increase in the counts was observed when samples were taken in the morning when the pH was lower, about neutral. It was concluded that increased pH contributes to reduction of the counts in the surface water.

The counts in the soil at the shore line were higher than surface counts in the pond but lower than observed with samples collected a foot and one-half below the surface. The soil counts may have been due to infusion of organisms into the soil during periods of high concentrations in the pond as would occur at night. The coliform counts at the shore line did not indicate the presence of any contamination due to floating matter or deposits of fecal matter. The only floating matter observed was a few bits of toilet paper and no accumulation of organic matter was observed. The counts on the bank are what would be expected from a similar area excluding the waste stabilization pond.

In comparing the coliform counts with the enterococci counts the coliform counts were approximately twice the enterococci counts. The correlation between the two counts confirms the usefulness of enterococci as an indicator organism.

VII. CONCLUSIONS

1. The counts taken at Point 1 on the bank do not indicate that the bank is receiving a major amount of contamination from the shore line and the pond.
2. There is no accumulation of organic matter at the shore line and no other evidence that the shore line is being contaminated by floating organic matter.
3. The reduction of the number of coliforms and enterococci in the surface water of the pond is associated with increased pH levels and with algae growth.
4. The enterococci counts of approximately one-half the coliform counts confirms the application of enterococci as an indicator organism.

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IX. ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Dr. W. A. Parsons for his patience and encouragement in the preparation of this thesis and for stimulation in the study of sanitary engineering as an undergraduate and as a graduate student. Thanks also go to Dr. W. E. C. Moore and Dr. K. W. King for their stimulation in the field of microbiology. Above all the author acknowledges his Creator, the creator and sustainer of the universe and the giver of life.

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Abstract

WASTE STABILIZATION PONDS: POSSIBLE CONTAMINATION OF THE SHORE

A waste stabilization pond was investigated to determine if there was a health hazard due to contamination of the shore line.

Soil samples were taken at various points along the bank and water samples were collected from the pond. Coliform and enterococci counts were made from the samples and were employed in conjunction with observations made of conditions at the sample points to determine if a health hazard existed at the shore line. Three stations were located along the leeward side of the pond. At each station samples were taken in adjacent soil, soil at the water line, water at the water line, water from the pond surface and water from one and one-half feet beneath the pond surface off shore. Using the geometric mean, coliform counts ranked as follows: 1717.7 water sample one and one-half feet below the surface and off shore, 583.9 soil sample at the water line, 79.0 soil on adjacent bank, 20.2 surface water sample off shore, and 11.5 water sample at water line.

The high count one and one-half feet below the surface is presumably from the sewage being added to the pond. Low counts were associated with pH values near ten. High counts generally occurred at more neutral pH values of about eight.

The counts at the water line are not high enough to indicate the presence of significant concentrations of fecal matter. Also, no fecal matter or other floating matter was observed at the shore line. The counts from the soil on the bank up from the shore line were what would be expected from a similar area excluding the waste stabilization pond.

A comparison of the coliform and enterococci counts showed that the enterococci count is approximately one half the coliform count which is in agreement with other investigations (2) and indicates its usefulness as an indicator organism.