A CONTAMINATION STUDY OF J. PERCY PRIEST RESERVOIR AND ITS TRIBUTARIES

LEE CRAUFURD FORREST

May 1970

To the Graduate Committee:

I am submitting herewith a thesis written by Lee Craufurd Forrest entitled "A Contamination Study of J. Percy Priest Reservoir and its Tributaries." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Biology.

Herbert C. Phillips

Major Professor

We have read this thesis and recommend its acceptance:

Charles D. Brehms

Minor Professor

Floyd M. Ford

Accepted for the Committee:

Wayne C. Stamper

Dean of Graduate School

A CONTAMINATION STUDY OF J. PERCY PRIEST RESERVOIR AND ITS TRIBUTARIES

AN ABSTRACT

Presented to

the Committee on Graduate Studies

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in Biology

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by

Lee Craufurd Forrest

May 1970

ABSTRACT

A contamination study was conducted at selected stations on J. Percy Priest Reservoir and its tributaries between November 3, 1968 and June 18, 1969. To determine the extent of contamination samples of the water were tested for the total coliform, fecal coliform and enterococcus bacteria by the Membrane Filter Technique.

Data from this study indicated that the reservoir and its tributaries were periodically contaminated. However, the water quality as indicated by those tests throughout the study met the standards recommended by the Tennessee Stream Pollution Control Board (1962) and the Federal Water Pollution Control Administration (1969).

Location of sampling areas, depth of samples, climate and seasons, and physical and biochemical conditions were factors that appeared to influence the presence and numbers of these groups.

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Chapter I

INTRODUCTION

The maintenance of inland waters is of growing concern in America today. Misuse, through pollution, is a primary cause for the alteration of the natural biological systems found in aquatic communities.

The bacteriological condition of an aquatic community may determine the present and future use of that community. In order to determine water quality several indicators of pollution may be used. Indication that intestinal pollution has occurred may be demonstrated by testing for the presence and number of certain bacterial groups.

The purpose of this investigation was to determine if the water in J. Percy Priest Reservoir and tributaries was polluted. This was accomplished by analyzing water samples for bacterial indices of pollution. Designated areas of J. Percy Priest Reservoir and tributaries were checked periodically from November 3, 1968 to June 18, 1969, to obtain samples for laboratory diagnosis.

The following laboratory tests were used in making the study:

1. Total coliform
2. Fecal coliform
3. Enterococci

This contamination study was the first of its kind to be carried out on J. Percy Priest Reservoir and its tributaries since its impoundment.

During the period of this study Mildred B. Perry also of Austin Peay State University, conducted a systematic study of the water quality of the reservoir using certain chemical indices (Perry, 1969).

Chapter II

GENERAL CHARACTERISTICS OF THE STUDY AREA

Description and Location

J. Percy Priest Reservoir is a newly impounded, May 1968, lake by the U.S. Army Corps. of Engineers, on Stones River. Its northern border extends from Stones River mile 6.8, eight miles east of Nashville, Tennessee, latitude 36° 10', longitude 86° 20', with its southern border at the confluence of the East Fork Stones River and the West Fork Stones River, near Old Jefferson community, latitude 35° 59', longitude 86° 20', a distance of approximately 37 river miles (Corps of Engineers, 1967). The East Fork Stones River, West Fork Stones River, and the Middle Fork Stones River are the main tributaries of the reservoir. However, there are numerous creeks and seasonal streams which form a part of the drainage system. The East Fork Stones River originates approximately 46 river miles from its confluence with the West Fork Stones River, near Woodbury in Cannon County. The West Fork Stones River originates approximately 25 river miles, in southern Rutherford County, before joining the East Fork Stones River. The head waters of the Middle Fork Stones River are in southeastern Rutherford County and empty into the West Fork at river mile 17.

A drainage area of approximately 892 square miles supplies the reservoir. This area, Stones River Drainage Basin, is a part of the Cumberland River Drainage Basin (Corps of Engineers, 1967). This drainage basin is almost entirely in the Central Basin of Tennessee. A large quantity of the water in the reservoir originates as surface runoff that flows into sinkholes, collects in underground streams, and reappears as springs (Parchment, 1961). These springs are numerous in the basin and eventually form meanders to the tributaries. Small quantities of water are discharged from these springs and the yield fluctuates with the season.

The water level of J. Percy Priest Reservoir is subject to fluctuations caused by winter and spring floods. The mechanical regulation of the water level is controlled by spillways at J. Percy Priest Dam (Corps of Engineers, 1967). During the flood season, winter and spring months, the elevation may be as high as 504.5 feet above sea level, with a surface area of 20,720 acres, whereas, during the summer and early fall, the elevation may be as low as 490 feet above sea level, with a surface area of 14,230 acres (Metropolitan Planning Commission, 1968).

Because of the fluctuation in surface area there is an extreme seasonal change in the physical appearance of the reservoir marked by the disappearance and reappearance of bays, lagoons, and inlets which make up the shoreline.

Geology

The geology of the study area may play an important role in the presence and number of the bacterial indicators of pollution. Burdick (1969) and Perry (1969) reported that the water in the reservoir was slightly alkaline because of limestone. The meanders and streams have exposed rock bottoms of limestone frequently fractured to a considerable extent. There are four different strata found in the Stones River Basin, they are: Murfreesboro Limestone, Pierce Limestone, Ridley Limestone, and Lebanon Limestone. These are referred to as the Stones River Group, of the Ordovician Period (Parchment, 1961).

The soil topography in the basin is: (1) level to rolling, very rocky, clay soils, (2) level to rolling, deep, terrace bottom soils, and (3) rolling to hilly, deep loamy soils (Metropolitan Planning Commission, 1968).

Public use

Several recreational and park sites have been constructed along the shoreline by local governments and the Corps of Engineers. The primary recreational uses of the reservoir and tributary surface waters are fishing and boating.

Effluent from the Murfreesboro sewage treatment plant is emptied into the West Fork Stones River. The effluent from the Woodbury sewage treatment plant and the Veteran's Hospital, Murfreesboro, is emptied into the East Fork Stones River. The only source of effluent discharge directly into the reservoir is the Radnor sewage treatment plant in Davidson County. Its outfall is in a bay near river mile 12. There is no known discharge of industrial wastes into the reservoir or its main tributaries.

Climate

The climate in the Central Basin is mild with rare extremes of heat or cold. The average mean annual temperature for the area is about 59° F. Except for some exceptional winters the temperature rarely goes below 20° F; and the summer temperature rarely exceeds 100° F (Blandon, 1969).

The ground is rarely covered by snow for more than a few days at a time, and the annual period of frost varies from 200 to 230 days. The annual average of 52 inches of rainfall is not considered excessive, but sufficient for the maintenance of the water level. The humidity is temperate with an annual average of 72%. During the fall and winter months the reservoir is swept by a southwest wind, while in the spring and summer the prevailing winds are from the north to northeast (Blandon, 1969).

Sampling stations

Sampling stations (Figures 1 and 2) were selected to establish: (1) a longitudinal profile of the reservoir, (2) the degree of contamination near recreational areas, (3) the effect of effluents in the tributaries, (4) contamination at designated locations in the drainage basin.

The stations were:

R-1 -West Fork Stones River, 300 yards from the mergence of the East Fork Stones River and West Fork Stones River

R-1'-Bottom

R-2 -East Fork Stones River, 300 yards from the merg-
ance with the West Fork Stones River

R-2'-Bottom

R-3 -Bay at mile 33 near the mouth of Fall Creek

R-3'-Bottom

R-4 -Channel at mile 30 southwest of Smyrna Road

R-5 -100 feet from Sewart Air Force Base

R-6 -Mouth of bay st Sewart Air Force Base, 100 feet from the river channel

R-6'-Bottom

R-7 -Channel at mile 28

R-7'-Bottom

R-8 -Channel at mile 25 near Hollandale Road

R-8'-Bottom

R-9 -Bay N.W. of Sewart Air Force Base near the mouth of Hurricane Creek

R-10 -Channel, N.E. at mile 22

R-10'-Bottom

R-11 -Bay, north of Sewart Air Force Base, west of Jones Mill Road

R-12 -Channel at mile 15, near Mt. View Road; a bridge is now under construction here

R-12'-Bottom

R-13 -Bay near Spring Creek at mile 14

R-13'-Bottom

R-14 -Bay at the mouth of North and Wright Creeks

R-15 -Channel at mile 12 near the Bay of R-14

R-15'-Bottom

R-16 -Small bay and recreation area 3/4 mi. S.W. of Dam

Dam -Samples were taken 400 feet south of Dam

Dam'-Bottom

T-1 -200 feet upstream from Woodbury sewage treatment plant, at mile 43.8 of East Fork Stones River

T-2 -2,000 feet downstream from Woodbury sewage treatment plant, at mile 43.4 of East Fork Stones River

T-3 -Bridge of Bettyford Road, at mile 15.1 of East Fork Stones River

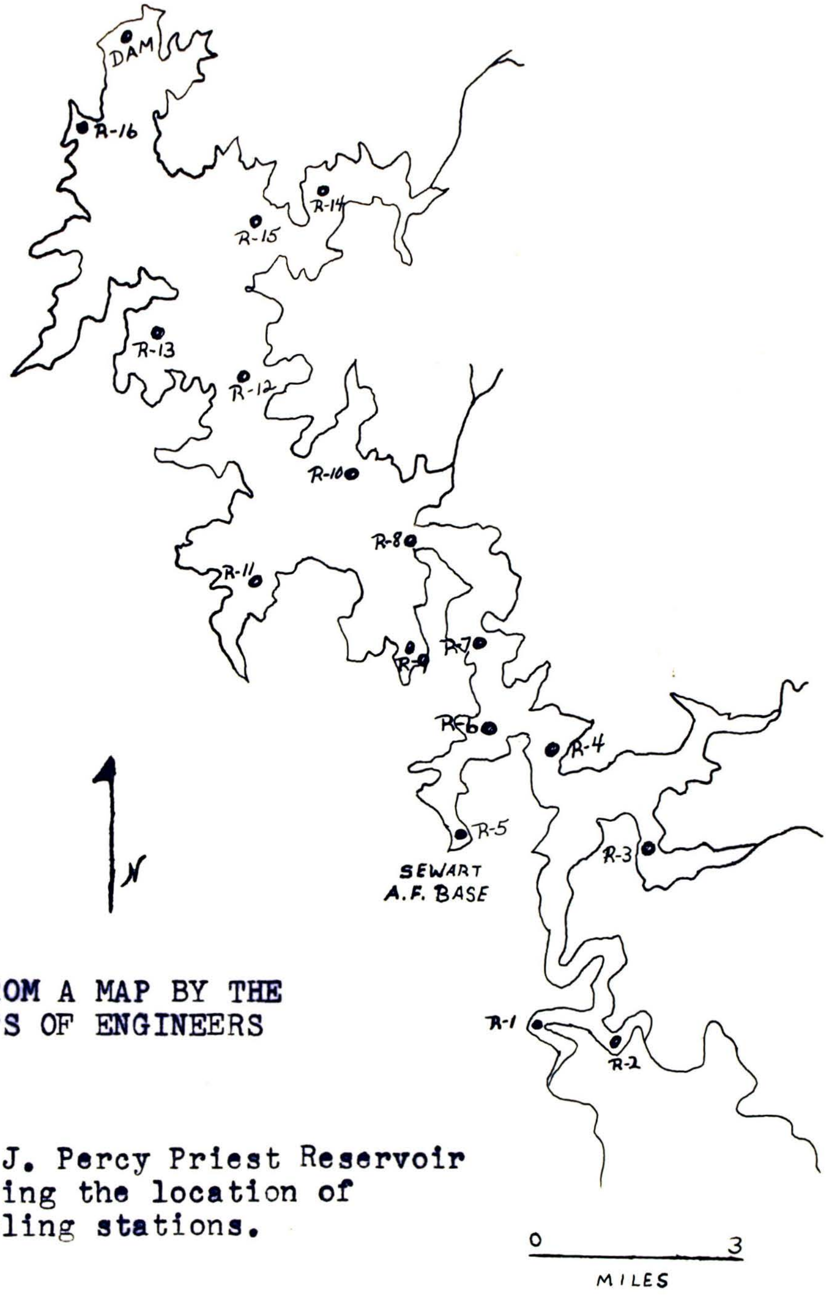
T-4 -Bridge on U.S. 231, Walter Hill Dam at mile 919 of East Fork Stones River

T-5 -Bridge on U.S. 231 south of Murfreesboro, at mile 1.8 of Middle Fork Stones River

T-6 -Bridge on Old Nashville Highway, at mile 15.8 of West Fork Stones River

T-7 -300 feet downstream from Murfreesboro sewage treatment plant, at mile 14.6 of West Fork Stones River

T-8 -Bridge on U.S. 70, at mile 5.3 of Steward's Creek



ADAPTED FROM A MAP BY THE
U.S. CORPS OF ENGINEERS

Figure 1. The J. Percy Priest Reservoir showing the location of sampling stations.

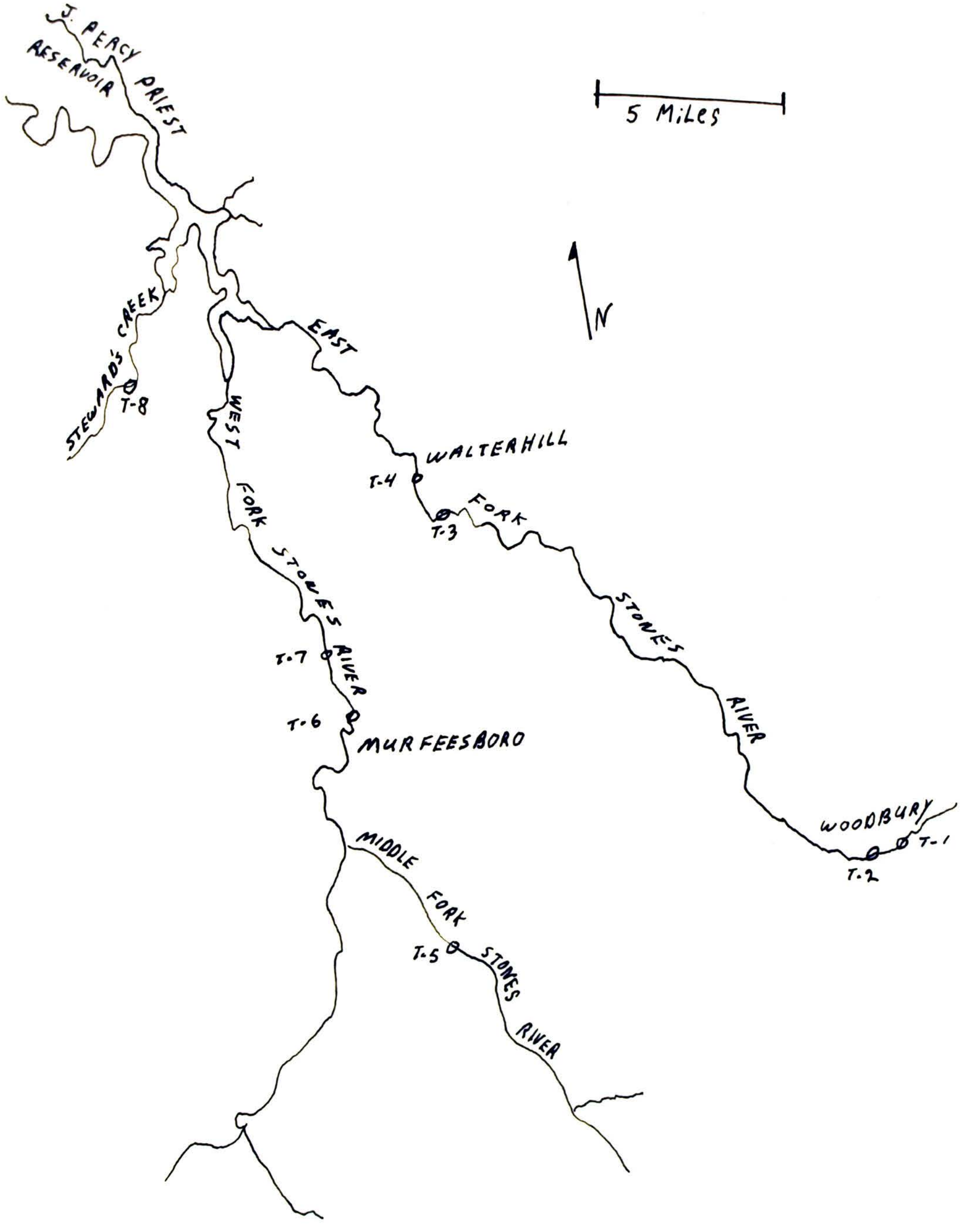


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Figure 2. Major tributaries of J. Percy Priest Reservoir showing the location of sampling stations.

Chapter III

METHODS AND MATERIALS

In order to accomplish the objectives of the study twenty-five sampling stations were chosen throughout the Stones River Drainage Basin. Eleven of these stations supplied bottom as well as surface samples. The number of samples collected at each station varied because of inclement weather conditions. A total of 192 samples were tested during the survey; 132 samples were collected from the surface and 60 samples were collected from the bottom.

All samples were collected in sterilized glass bottles, which were tightly sealed until an analysis could be made that day. Following the recommendations in Standard Methods (1965) the samples were not refrigerated during transportation, but the temperature was kept as close as possible to that at the time of sampling by use of a urethane chest. Surface samples were collected one foot below the surface to eliminate floating debris, and bottom samples were collected with a Matheson 65035-10 Water Sampler one yard from the bottom to minimize bottom sediment.

Temperature was taken with an ordinary Centigrade thermometer at stations T-1, T-2, T-3, T-4, T-5, T-6, T-7, and T-8. At all remaining stations temperature was taken with the thermister jack of the Galvanic Cell Oxygen Analyzer; the readings of this instrument were compared with a Centigrade thermometer at the beginning of each sampling period to assure standard values (Perry, 1969).

The micropore membrane filter technique was used in the laboratory analyses of all samples. This technique for microbiological analysis was adopted from the Millipore Corp. (1965) and Standard Methods (1965). Analysis was begun immediately after arrival of samples from the field. The procedures of analyses varied, because tests were run to determine numbers and presence of three bacterial indicators. The observation and counting of all colonies was accomplished with a 10X binocular dissecting microscope, immediately following the incubation period.

MF-Endo Broth was used for determining total coliform. Filtration volumes of 1 ml and 10 ml produced the most favorable numbers of total coliform colonies for counting. Cultures were incubated at 35° C for 18 hours. After incubation, the colonies on the filters having a greenish metallic sheen were considered to be of the coliform group (Standard Methods, 1965).

To recover fecal coliform from water samples, M-FC Broth Base was used as the selective medium. Volumes of 10 ml and 100 ml from each sample produced a satisfactory number of colonies. In order to maintain the constant temperature required for growing these organisms, dishes were incubated in waterproof plastic bags submerged in a water bath. They were incubated at 44.5 ± .5° C for 24 hours. The organisms forming blue colonies on this medium were defined by Geldreich (1966) as fecal coliform. These colonies were counted by using a 10X binocular dissecting microscope.

Enterococcus was determined by placing the filters through which 50 ml and 200 ml of water had been filtered on M-Enterococcus Agar (Standard Methods, 1965). When samples were highly turbid the maximum practical volume was 100 ml because of clogging of the filters. The dishes were incubated for 48 hours at 35° C. Enterococci grew as pink and/or red colonies on the filter. These colonies, also, were counted by using a 10X binocular dissecting microscope.

The estimated numbers of total coliforms, fecal coliforms, and enterococci are reported in terms of bacterial indicators per 100 ml. The following equation (Standard Methods, 1965) was used to derive these densities:

$$\frac{\text{pollutant colonies}}{\text{100 ml}} = \frac{\text{pollutant colonies counted X 100}}{\text{ml. sample filtered}}$$

	TOTAL COLIFORM	FECAL COLIFORM	ENTEROCOCCUS
MEDIA	MF-Endo Media	M-FC Base Broth	M-Enterococcus Agar
Filtrate volumes	1 ml & 10 ml	10 ml & 100 ml	50 ml & 100 ml
Incubation time	18 hours	24 hours	48 hours
Incubation temperature	35° C	$44.5 \pm .5^{\circ}$ C	35° C
Color of colonies	green metallic sheen	blue	pink or red

Figure 3. A summary of the micropore filter technique used to analyze the bacterial indicators (Millipore Corp., 1965).

Chapter IV

RESULTS AND DISCUSSION

Temperature

The temperature of the water samples varied considerably during the survey. The minimum surface temperature was 2.5° C on January 11, 1969, at Station R-6 (Table 2) and the maximum surface temperature was 25.5° C on June 18, 1969 at Stations R-5, R-13, R-14 and R-16 (Table 7). The minimum bottom temperature was 2.5° C on January 11, 1969 at Stations R-3 and R-6 (Table 2) and the maximum bottom temperature 23.5° C on June 18 at Stations R-3 and R-6 (Table 7). Therefore, comparison of water temperatures reflected seasonal decline and rise in air temperature.

During the months when the temperature was below 10° C the coliform group was on the decline. As the water temperature increased the density of coliforms found in the samples increased. Besselievre (1952) reported that temperatures below 10° C will inhibit bacterial life and retard action temporarily.

During those months when the water temperature ranged above 10° C it was possible that coliforms multiplied, while the fecal coliforms and the enterococci remained at the concentration in which they entered the water. The Federal Water Pollution Control Administration (1969) reported that some strains of the coliform may increase in polluted waters; also that fecal coliforms generally do not multiply outside the intestine of warm-blooded animals. Furthermore, the density of enterococci appeared not to be affected by the extremes in water temperature. Kabler (1960) observed that enterococci do not multiply in streams or other surface water. He mentioned that their presence indicated pollution and that the concentration did not increase after entry into surface water.

Bacteriological Studies

The bacteriological data for each sampling period along with the temperature and depth of each sample are shown in Tables 1-7. These data show the fluctuation in number of bacterial indicators at each sampling station during a particular sampling period. The concentration of total coliforms, fecal coliforms, and enterococci appear to vary as to the depth, temperature, and date of sample. For example, Station R-12 on November 3, 1968 had a surface temperature of 15.5° C, a total coliform count of 4,250 per 100 ml, a fecal coliform count of 135 per 100 ml, and an enterococcus count of 1.0 per 100 ml. Whereby, a sample at 28 ft. at this station the same day had a temperature of 12.4° C, a total coliform count of 550 per 100 ml, a fecal coliform count of 90 per 100 ml, and an enterococcus count of 2.0 per 100 ml (Table 1). Furthermore, two months later on January 11, 1969 at Station R-12 the surface temperature was 3.5° C, with a total coliform count of 160 per 100 ml, a fecal coliform count of 1.0 per 100 ml, and an enterococcus count of 2.0 per 100 ml. The sample taken at 43 ft. at this station the same day was 4.0° C, and had a total coliform count of 5.0 per 100 ml, a fecal coliform count of 0.0 per 100 ml, and an enterococcus count of 1.0 per 100 ml (Table 2).

Most of the data shown in these Tables displayed similar patterns of fluctuation. These fluctuations in numbers of bacteria were a very important finding of the study.

The total coliform, fecal coliform, and enterococcus counts are tabulated in Tables 1-9. Water temperature, depth of samples, numbers of bacteria per 100 ml are shown in Tables 1-7. These listings display the fluctuations of the above from station to station and sampling period to sampling period. By reviewing these Tables the locations high in number of total coliform fecal coliform, and/or enterococci may be determined. These locations free or low in bacterial contamination, also may be determined.

Reference to Table 8 shows the bacterial indicator, date of sample, stations, and highest or lowest concentration of a specific bacterial indicator.

These listings, along with those in Tables 1-7, show that the heaviest concentration of bacterial indicators were in the upper reaches of the reservoir and as the samples were taken progressively nearer the Dam the density decreased. In general, samples collected in the reservoir past Station R-4 had a relatively low concentration of bacterial indicators. Those bacterial indicators associated with excreta from warm-blooded animals were infrequent in most of the reservoir (Table 9). During periods of surface drainage there appeared to be an increase in all bacterial indices, however, this problem was reduced with the end of extensive drainage (Table 9). The greatest amount of contamination of probably animal origin occurred in the tributaries (Table 9). Periodic sampling on the East Fork Stones River, West Fork Stones River, Middle Fork Stones River and Steward's Creek indicated a sharp increase in the numbers of these bacterial indicators from warm-blooded animals occurred on May 10, 1969 and June 18, 1969 (Table 9). Extensive use of the land for pasture and surface runoff may be responsible for this increase (Kittrell and Furfari, 1963).

One of the objectives of this survey was to determine if the effluent from the three sewage treatment plants was contributing to the bacterial contamination in the tributaries. A definite decrease was noted in the numbers of enteric bacteria in West Fork Stones River after the effluent of the Murfreesboro plant was added to the stream (Tables 2, 3, 4, 6, and 7). Often no organisms were recovered from Station T-7 below the plant, whereas a moderate number of bacterial indicators were recovered at Station T-6 above the plant. This was probably due to the chlorine content in the water at Station T-7. The influence of the

Woodbury plant on the bacterial contamination was questionable, that is, the concentration of bacterial indicators from warm-blooded animals was greater at Station T-2 below the plant than at Station T-1 above the plant (Tables 2, 3, 4, 6, and 7). The influence of the effluent from the Veteran's Hospital on the bacterial indicators was difficult to determine; there was a decrease in total coliform, fecal coliform, and enterococci numbers at Station T-4, below the hospital, over the concentration at Station T-3, above the hospital (Tables 2, 3, 4, 6, and 7).

Because of natural purification, dilution, absence of nutrients, flocculation followed by sedimentation, predatory activity of protozoa, antibiotic activity of algae and bacteriophages resulting in the lysis of bacterial cells the number of total coliform, fecal coliform, and enterococci decreased as they were gathered in the main body of water (Tennessee Stream Pollution Control Board, 1962).

Table 9 demonstrates an improved technique employing ratios and percentages of the relationship of bacterial indices as well as median values of total coliform, fecal coliform, and enterococci in the reservoir and its tributaries. The table shows the sampling periods; location (reservoir and tributaries); total coliform per 100 ml., fecal coliform per 100 ml., and enterococci per 100 ml.; percentage of fecal coliform over total coliform, percentage of enterococci over total coliform, and percentage of enterococci over fecal coliform; and the ratios of TC/E, FC/E, TC/FC, and E/FC. The data demonstrate that the majority of fecal contamination in the drainage system occurred in the tributaries and not in the reservoir. Throughout the entire survey 172,088 colonies of total coliform, 7,078 colonies of fecal coliform, and 1,620 colonies of enterococci were recovered from the reservoir (Table 9). Geldreich (1966), Jeter (1969), Kabler (1960), Tennessee Stream Pollution Control Board (1962), Federal Water Pollution Control Administration (1969), and Davis, et al. (1968) recommended various indices to follow concerning interpretation of sanitary quality. Davis et al. (1968) mentioned several established standards for water quality: source of domestic raw water supply--less than 5,000 coliform bacteria per 100 ml , swimming--less than 1,000 coliforms per 100 ml. Furthermore, water with over 10 enterococci per 100 ml was of doubtful sanitary quality and greater than 100 per 100 ml indicated a high degree of recent fecal pollution.

Geldreich (1966) stated that fecal coliform organisms may be considered indicators of recent fecal pollution. "No satisfactory method is currently available for differentiating fecal coliform organisms of human and animal origin. Therefore, it is necessary to consider all fecal coliform organisms as indicative of dangerous contamination (Geldreich, 1966)." Geldreich (1967a) reported that ratios greater than 4 to 1 fecal coliforms to enterococci usually indicated the pollution was derived from domestic wastes. Ratios less than 0.7 to 1 fecal coliform to enterococci, suggested the pollution was derived from livestock and poultry wastes found in rural areas (Federal Water Pollution Control Administration, 1969).

The ratio of fecal coliforms to enterococci fluctuated greatly during the survey (Table 9). The highest ratio of 24.25 to 1 occurred in the reservoir on May 10, 1969 whereas the lowest ratio of 0.87 to 1 in the reservoir occurred on June 18, 1969. These ratios pointed out the effect of surface runoff to the numbers of bacterial indicators and the presence of intestinal wastes of human origin. The Federal Water Pollution Control Administration (1969) reported the ratio between FC/E tends to be greater than two-to-one in human wastes, while in wastes from animals other than human, the ratios were less than one-to-one.

The average fecal coliform number, to total coliforms during the survey was 5%. This percentage in the reservoir was 4.1% and in the tributaries it was 8.8% (Table 9). Federal Water Pollution Control Administration (1969) stated that in environmental waters relatively free from recent pollution, the fecal coliform number may range commonly from 1-10% that of the total coliform. These data indicate that the water of the reservoir and tributaries was not heavily contaminated with bacterial indicators from warm-blooded animals.

Tests for total coliforms have been used in this country for over 60 years. The absence of this bacterial indicator is evidence of bacteriologically safe water (Kittrell and Furfari, 1963). Total coliforms were recovered in most of the samples taken during this survey. By calculation Tables 1-9 were used in interpreting the relationship between the total coliforms, fecal coliforms, and enterococci. The results of these relationships indicated that the drainage basin was subject to contamination of 93.99% total non-fecal coliforms, 4.71% fecal coliforms, and 1.3% enterococci, the reservoir had 95.5% total non-fecal coliform, 3.93% fecal coliform, and 0.57% enterococci, the tributaries had 88% total non-fecal coliform, 7.78% fecal coliform, and 4.22% enterococci.

TABLE 1

Bacteriological Data for November 3, 1968

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
R-1	0	16.5	1650	186	4
R-2	0	16.5	1725	125	2
R-4	0	16.0	2000	81	12
R-4'	14	16.5	1300	168	3
R-3	0	16.5	900	35	2
R-5	0	16.0	1210	69	4
R-6	0	16.5	4750	179	2
R-6'	22	16.5	210	35	15
R-7	0	16.0	525	135	4
R-7'	32	12.5	9500	43	13
R-8	0	16.5	80	0	1
R-8'	14	16.5	1800	226	0
R-9	0	15.5	3210	40	0
R-10	0	17.0	600	9	1
R-10'	26	16.5	575	30	1
R-11	0	15.0	1300	15	5
R-12	0	15.5	4250	135	1
R-12'	28	12.4	550	90	2
R-13	0	15.5	6000	100	2
R-13'	27	12.3	300	48	13
R-14	0	16.5	1900	120	1
R-14'	18	16.0	1300	82	1
R-15	0	16.0	990	10	1
R-15'	50	11.5	1150	1	2
R-16	0	17.0	650	55	1
Dam	0	17.0	2270	7	3
Dam'	50	11.5	1150	75	1

TABLE 2

Bacteriological Data for January 11, 1969

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
R-1	0	3.5	1800	18	14
R-1'	4	3.0	460	10	6
R-2	0	4.0	335	6	11
R-2'	18	4.0	155	0	8
R-3	0	3.5	350	5	5
R-3'	4	2.5	405	30	8
R-4	0	3.8	200	3	9
R-5	0	3.8	70	0	1
R-6	0	2.5	350	0	7
R-6'	20	2.5	60	-	6
R-7	0	3.8	550	10	10
R-7'	25	3.8	80	0	9
R-8	0	4.3	1600	45	21
R-8'	20	4.0	490	50	13
R-9	0	3.0	175	5	13
R-10	0	3.5	500	50	14
R-10'	38	4.0	10	4	9
R-12	0	3.5	160	1	2
R-12'	43	4.0	5	0	2
R-13	0	3.5	20	0	1
R-13'	40	4.0	100	-	1
R-14	0	3.3	100	0	3
R-15	0	3.8	0	0	2
R-15'	-	3.0	10	3	2
R-16	0	3.5	10	0	1
Dam	0	4.0	10	0	1
T-1	0	4.5	325	12	1
T-2	0	5.0	80	9	7

TABLE 2 (continued)

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
T-3	0	4.5	350	7	20
T-4	0	4.5	215	-	7
T-5	0	4.0	300	-	11
T-6	0	4.5	10	2	5
T-7	0	7.0	10	6	0
T-8	0	4.0	15	2	5

TABLE 3

Bacteriological Data for February 22, 1969

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
T-1	0	8.5	495	90	18
T-2	0	9.0	70	8	12
T-3	0	9.5	850	0	0
T-4	0	9.5	38	12	8
T-5	0	8.5	115	35	23
T-6	0	9.5	38	81	11
T-7	0	11.0	10	0	0
T-8	0	11.0	960	45	18

TABLE 4

Bacteriological Data for March 22, 1969

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
R-1	0	12.5	950	65	8
R-1'	30	5.9	1300	149	35
R-2	0	12.0	220	130	13
R-2'	20	6.0	855	125	5
R-3	0	12.0	20	4	0
R-3'	5	8.0	105	25	0
R-4	0	12.0	70	0	6
R-5	0	12.0	60	25	0
R-6	0	11.0	10	20	0
R-6'	23	9.5	100	30	1
R-7	0	11.0	10	0	0
R-7'	28	5.9	80	30	2
R-8	0	11.0	90	3	0
R-8'	23	5.9	70	3	0
R-9	0	10.5	0	0	0
R-10	0	10.5	0	0	0
R-10'	30	5.9	20	0	1
R-11	0	10.5	95	80	0
R-12	0	9.5	0	0	0
R-12'	36	5.8	190	10	0
R-13	0	10.0	0	0	0
R-13'	35	5.9	100	10	0
R-14	0	11.5	20	0	0
R-15	0	10.0	30	10	0
R-15'	40	5.8	85	10	0
R-16	0	10.5	10	0	2
Dam	0	11.0	0	0	0

TABLE 4 (continued)

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
Dam'	60	5.8	175	33	0
T-1	0	8.0	440	353	18
T-2	0	8.5	40	30	1
T-3	0	12.0	150	64	1
T-4	0	13.0	290	97	0
T-5	0	11.5	1150	93	31
T-6	0	12.0	185	75	22
T-7	0	14.0	210	1	0
T-8	0	12.0	135	65	7

TABLE 5

Bacteriological Data for April 19, 1969

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
R-1	0	17.3	4000	375	103
R-1'	40	10.2	630	15	37
R-2	0	15.0	390	92	34
R-2'	27	11.3	1250	30	135
R-4	0	17.0	250	4	7
R-5	0	16.0	2850	1100	77
R-6	0	16.5	1300	60	9
R-6'	40	10.0	905	26	38
R-7	0	16.5	210	60	6
R-7'	53	8.7	175	33	7
R-8	0	17.5	255	10	4
R-8'	15	14.8	150	7	5
R-9	0	16.5	40	3	0
R-10	0	17.5	50	32	3
R-10'	36	10.3	450	45	3
R-11	0	17.5	180	48	4
R-12	0	17.0	60	0	0
R-12'	60	8.0	335	20	6
R-13	0	18.0	20	5	0
R-13'	50	9.0	10	1	2
R-14	0	19.0	450	2	0
R-15	0	18.5	130	10	0
R-15'	25	13.0	75	3	5
R-16	0	15.0	100	3	0
Dam	0	16.4	420	15	0
Dam'	45	9.5	0	0	0

TABLE 6

Bacteriological Data for May 10, 1969

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
R-1	0	20.0	200	0	2
R-1'	15	17.0	135	63	2
R-2	0	20.0	1320	275	0
R-2'	28	14.5	450	145	1
R-3	0	20.0	700	35	0
R-3'	10	18.0	370	39	2
R-4	0	19.5	1160	109	0
R-5	0	18.5	2100	0	0
R-6	0	20.0	1050	10	0
R-6'	30	14.4	3750	103	1
R-7	0	19.0	610	10	8
R-7'	20	16.7	6010	55	3
R-8	0	19.5	5215	9	0
R-8'	30	14.3	9305	8	0
R-9	0	19.0	8910	285	0
R-10	0	19.5	3140	14	2
R-10'	35	12.2	1150	3	1
R-11	0	19.0	7815	15	3
R-12	0	19.0	1065	196	1
R-12'	45	9.7	440	12	0
R-13	0	19.0	3400	26	0
R-13'	40	16.7	2000	45	0
R-14	0	----	2805	125	45
R-15	0	20.0	5205	46	0
R-15'	50	9.0	3525	0	2
R-16	0	19.5	8360	196	2
Dam	0	20.0	2650	0	1

TABLE 6 (continued)

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
Dam'	60	8.7	6450	25	0
T-1	0	14.0	2650	259	294
T-2	0	14.5	7705	205	142
T-3	0	18.0	890	148	120
T-4	0	20.0	5575	74	72
T-5	0	18.0	1255	256	130
T-6	0	19.0	475	101	158
T-7	0	18.0	0	2	0
T-8	0	16.0	510	116	27

TABLE 7

Bacteriological Data for June 18, 1969

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
R-1	0	25.0	100	10	13
R-1'	44	11.0	130	19	4
R-2	0	25.0	360	5	0
R-2'	40	12.0	75	9	4
R-3	0	24.5	95	10	5
R-3'	15	23.5	18	0	4
R-4	0	25.0	100	0	2
R-5	0	25.5	1155	24	12
R-6	0	25.0	50	1	2
R-6'	10	23.5	10	6	3
R-7	0	25.0	10	0	14
R-7'	28	17.0	255	3	13
R-8	0	24.5	110	1	2
R-8'	29	16.4	75	0	1
R-9	0	25.5	0	0	0
R-10	0	24.5	0	0	0
R-10'	34	14.0	65	1	6
R-11	0	26.0	10	0	1
R-12	0	25.0	10	0	0
R-12'	58	9.5	60	1	2
R-13	0	25.5	60	0	0
R-13'	45	11.0	425	10	33
R-14	0	25.5	190	10	1
R-15	0	25.0	0	0	0
R-15'	50	10.5	185	0	4
R-16	0	25.5	10	0	0
Dam	0	24.5	10	0	0

TABLE 7 (continued)

Station	Depth ft.	Temp. °C H_2O	Total Coliform per 100 ml	Fecal Coliform per 100 ml	Enterococci per 100 ml
Dam'	50	10.0	30	0	1
T-1	0	16.5	3250	139	118
T-2	0	17.0	2700	550	147
T-3	0	21.0	960	44	56
T-4	0	22.0	925	32	110
T-5	0	19.0	1000	109	132
T-6	0	19.5	3755	215	63
T-7	0	19.5	0	5	2
T-8	0	20.0	2050	225	131

TABLE 8

Summary of Bacteriological Data

Bacterial indicator	Maximum per 100ml	Date	Station	Minimum per 100ml	Date	Station
I. Reservoir						
Surface						
Total Coliform	8910	5-10-69	R-7	0	1-11-69	R-15
					3-22-69	R-9, 10, 12, 13, Dam
					6-18-69	R-9, 10, 15
Fecal Coliform	1100	4-19-69	R-5	0	11-3-68	R-8
					1-11-69	R-5, 6, 13, 14, 15, 16, Dam
					3-22-69	R-4, 7, 9, 10,13, 14, 16, Dam
					5-10-69	R-1, 5, Dam
					6-18-69	R-4, 7, 9, 10, 11, 12, 15, 16, Dam
Enterococci	103	4-19-69	R-1	0	11-3-68	R-9
					3-22-69	R-4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, Dam
					4-19-69	R-9, 12, 13, 14, 15, 16, Dam
					5-10-69	R-3, 4, 5, 6, 8, 9, 13, 15
					6-18-69	R-2, 9, 10, 12, 13, 15, 16, Dam

TABLE 8 (continued)

Bacterial indicator	Maximum per 100ml	Date	Station	Minimum per 100ml	Date	Station
Bottom:						
Total Coliform	9305	5-10-69	R-8	0	4-19-69	Dam
Fecal Coliform	149	3-22-69	R-1	0	1-11-69	R-7, 12
					3-22-69	R-10
					4-19-69	Dam
					5-10-69	R-15
					6-18-69	R-3, 8, 12, 15, Dam
Enterococci	135	4-19-69	R-2	0	11-3-68	R-8
					3-22-69	R-3, 8, 12, 13, 15, Dam
					4-19-69	Dam
					5-10-69	R-7, 8, 12, 13, Dam
II. Tributaries						
Surface:						
Total Coliform	7705	5-10-69	T-2	0	5-10-69	T-7
					6-19-69	T-7
Fecal Coliform	353	3-22-69	T-1	0	2-22-69	T-3, 7
Enterococci	294	5-10-69	T-1	0	1-11-69	T-3, 7
					2-22-69	T-3, 7
					3-22-69	T-7
					5-10-69	T-7

TABLE 9

Periodic Variations (Median Values) of Bacterial Indicators in J. Percy Priest Reservoir and Tributaries, November 3, 1968 to June 19, 1969

Date	Source	Total Coliform Per 100ml	Fecal Coliform Per 100ml	Entero-cocci Per 100ml	%FC/TC	%E/TC	%E/FC	Ratio TC/E	Ratio FC/E	Ratio TC/FC	Ratio E/FC
11-3	Res.	51845	2099	91	4.0	0.1	4.3	56.96	23.6	24.14	0.43
	Tri.	-	-	-	-	-	-	-	-	-	-
	Total	51845	2099	91	4.0	0.1	4.3	56.96	23.6	24.14	0.43
1-11	Res.	8005	240	174	2.9	2.1	72.5	33.85	1.66	33.85	.72
	Tri.	1305	38	56	2.9	4.5	147.3	23.0	.38	34.13	1.47
	Total	9310	278	230	2.9	2.4	82.7	40.0	1.48	33.13	.83
2-22	Res.	-	-	-	-	-	-	-	-	-	-
	Tri.	2576	271	90	10.5	3.4	33.2	28.56	3.1	9.13	.33
	Total	2576	271	90	10.5	3.4	33.2	28.56	3.1	9.13	.33
3-22	Res.	4665	781	65	16.7	1.3	8.3	71.5	12.1	5.76	.08
	Tri.	2600	768	80	29.5	3.0	10.4	32.4	9.48	3.29	.1
	Total	7265	1549	145	21.3	1.9	9.3	50.1	10.99	4.1	.09
4-19	Res.	14685	1999	485	13.6	3.3	24.2	30.1	4.59	7.69	.24
	Tri.	-	-	-	-	-	-	-	-	-	-
	Total	14685	1999	485	13.6	3.3	24.2	30.1	4.59	7.69	.24
5-10	Res.	89290	1849	76	2.0	.08	4.1	1174.6	24.25	48.53	.04
	Tri.	19060	1161	943	6.0	4.9	81.2	20.2	1.2	16.48	.81
	Total	108350	3010	1019	2.7	0.9	33.8	106.3	2.97	35.30	.34

TABLE 9 (continued)

Date	Source	Total Coliform Per 100ml	Fecal Coliform Per 100ml	Enterococci Per 100ml	%FC/TC	%E/TC	%E/FC	Ratio TC/E	Ratio FC/E	Ratio TC/FC	Ratio E/FC
6-19	Res.	3598	110	127	3.1	3.5	115.4	28.4	0.87	32.68	1.15
	Tri.	14640	1319	759	9.0	5.1	57.5	19.2	1.56	11.13	0.58
	Total	18238	1429	886	7.8	4.8	62.0	20.5	1.54	12.11	0.62
TOTAL											
	Res.	172,088	7078	1020	4.1	0.5	14.4	168.7	6.95	24.22	0.14
	Tri.	40,181	3557	1928	8.8	4.7	54.2	20.2	1.80	11.1	0.54
	Total	212,269	10635	2948	5.0	1.3	27.7	72.13	3.17	19.1	0.28

Chapter V

SUMMARY

Water samples examined from Stones River Drainage System indicated its degree of contamination from November 3, 1968 to June 18, 1969. Seasonal differences in the bacterial numbers of total coliforms, fecal coliforms, and enterococci were noted in a study of median values (Table 9). The fecal coliform segment of total coliform for all water samples averaged 5%, however, from tributary samples collected on March 22, 1969 they averaged 29.5%. In the reservoir the fecal contamination was less than in the tributaries. The median values indicated that the greatest environmental influence on the water quality was the surface runoff (Table 9).

The temperature of the water samples was an important factor influencing the density of bacterial indicators of contamination. When the water temperature increased over 16° C so did the number of bacterial indicators (Tables 1-7).

Generally, no specific area sampled in the reservoir was considered suspicious of pollution for the entire survey, however, because of their locations, Stations R-1 and R-2 received contamination from the East Fork Stones River and West Fork Stones River (Tables 1, 2, 4, 5, 6, and 7). The samples taken in the reservoir on May 10, 1969 were high in total coliform organisms because of surface runoff in the area, but low in fecal coliform and enterococci.

The effluent from three sewage treatment plants did not contaminate the drainage area during the sampling period. However some contamination was noted from the Woodbury Plant. High fecal coliform and enterococcus counts were recorded in the tributaries during periods of excessive surface runoff (Table 9).

On May 10, 1969 Station R-5 had a fecal coliform count of 1,100 per 100 ml (Table 6). This was the highest concentration of fecal coliform detected during the study. The probable cause was excessive drainage of storm sewers from Sewart Air Force Base.

During the period of this study the water quality fluctuated due to surface runoff and seasonal decline, however, according to standards of water quality criteria established by the Tennessee Stream Pollution Control Board (1962) and Federal Water Pollution Control Administration (1969), J. Percy Priest Reservoir and its tributaries, at the time of the study, was relatively safe for public use. The bacterial count in the reservoir during the last sampling period, June 18, 1969 was considered safe for swimming and water skiing (Table 7).

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