A STUDY

OF

TOTAL COLIFORM AND BIOCHEMICAL OXYGEN DEMAND

AT CAÑO CORAZONES

BY

CHI-MING CHAM

OCEANOGRAPHIC PROGRAM

AREA OF NATURAL RESOURCES

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WATER RESOURCES RESEARCH INSTITUTE

UNIVERSITY OF PUERTO RICO, MAYAGUEZ

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ABSTRACT

Total coliform and biochemical oxygen demand were studied at Caño Corazones from 21 July to 2 August 1972. 110 samples were taken for total coliform analysis, and 80 samples were taken for biochemical oxygen demand. The samples were collected at ten stations at selected locations in the area. Sixty-five percent of the total coliform values were higher than 2,400 MF/100ml, with the lowest eleven day median at 1,400 MF/100ml (at station VI), and the highest eleven day median at 117,000 MF/100ml (at station III). These values indicate an acute level of sewage pollution. It is suggested from the findings that the major source of pollution in Caño Corazones is the outfall from the sewage treatment plant of Guanajibo Homes. The other source of pollution in this area is the artificial stream carrying sewage water from the cattle farms. The concentration of eight day average BOD_5 varied from 3.52 mg/l (at station I) to 7.44 mg/l (at station III). BOD_5 values were higher at the more inland stations than at the stations in the estuarine area, closer to the sea. Possibly, mangrove leaves fall into the water, and are decomposed by bacteria, thus increasing BOD_5 values at the more inland sites.

Comparison of variance values of total coliform and biochemical oxygen demand indicates that the ten stations at Caño Corazones show larger significant differences in total coliform levels than in biochemical oxygen demand levels.

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INTRODUCTION

The delicate natural blance of ecological systems is often modified through human activities that result in the introduction of sewage and other organic pollutants which bring about either abrupt or gradual changes in the condition of the natural environment. With the continuing expansion and proliferation of urban areas, and the growing threat of pollution of waters which are needed for domestic, industrial, and/or recreational purposes, it is hoped that this study will be an aid to those who must make decisions regarding future courses of action.

DESCRIPTION OF STUDY AREA

Caño Corazones is located at longitude 18°10'30"-18°11'00" and latitude 67°10'00"-67°10'30" (Figure 1), on Route 102 at Km 5, Hm 7, at Mayaguez, Puerto Rico. At the northern side of Caño Corazones is a farm, and the southern side lies close to a housing development known as Guanajibo Homes. Many mangrove trees grow at the upper (inland) portion of the area. Caño Corazones receives salt water from the sea, and possibly fresh water from underground sources. It receives waste water from three streams which originate in the mangrove forest. It also receives waste water and sewage from the sewage treatment facility serving Guanajibo Homes, and water from an artificial stream carrying wastes and sewage from the cattle farms to the north.

STATION LOCATIONS

Figure 1 shows Caño Corazones and its surroundings. Figure 2 illustrates the location of sampling stations. Stations I and II were located on the seaward (estuarine) side of the study area, 10 and 60 meters from the

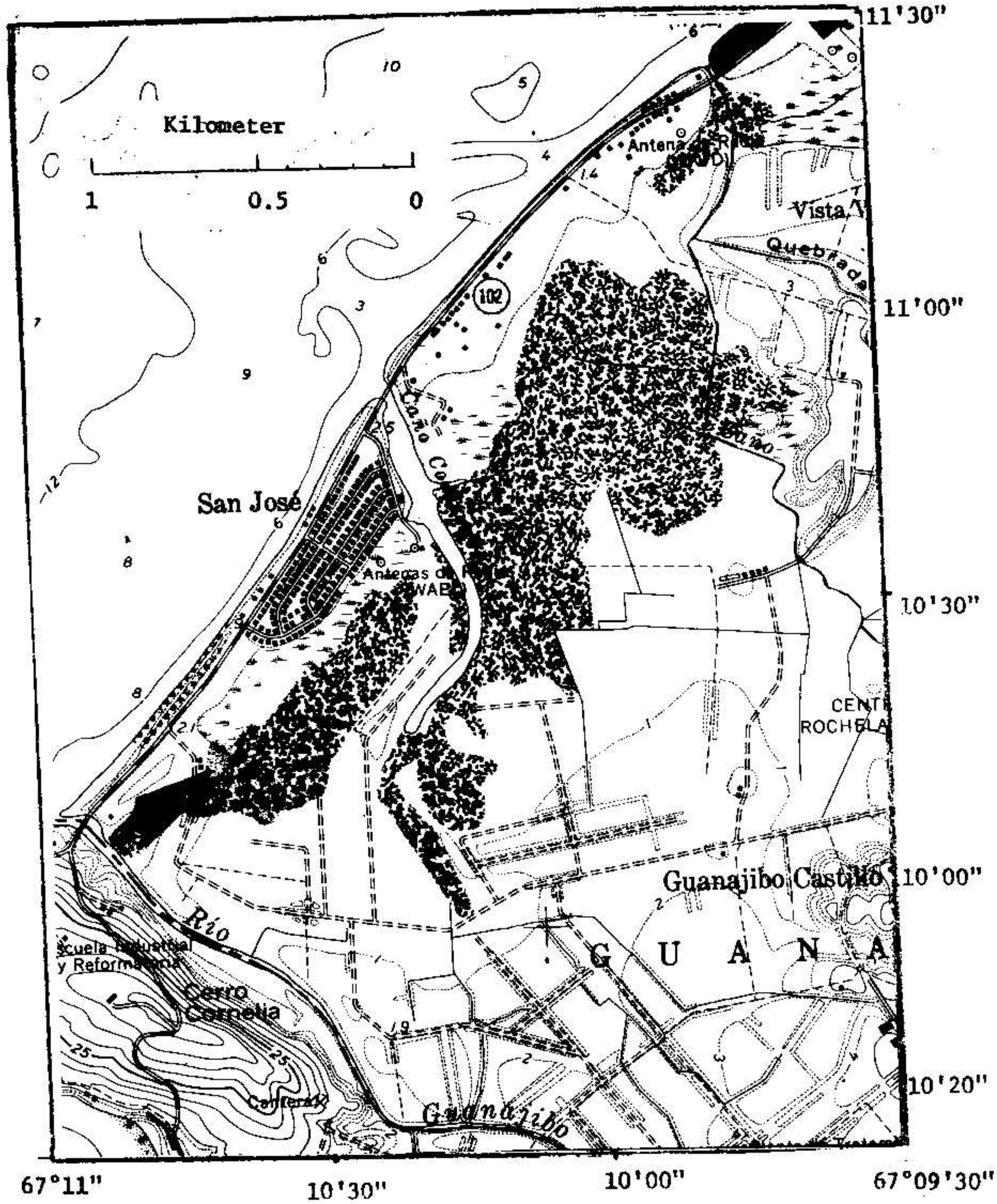

Fig. 1 Location of Caño Corazones

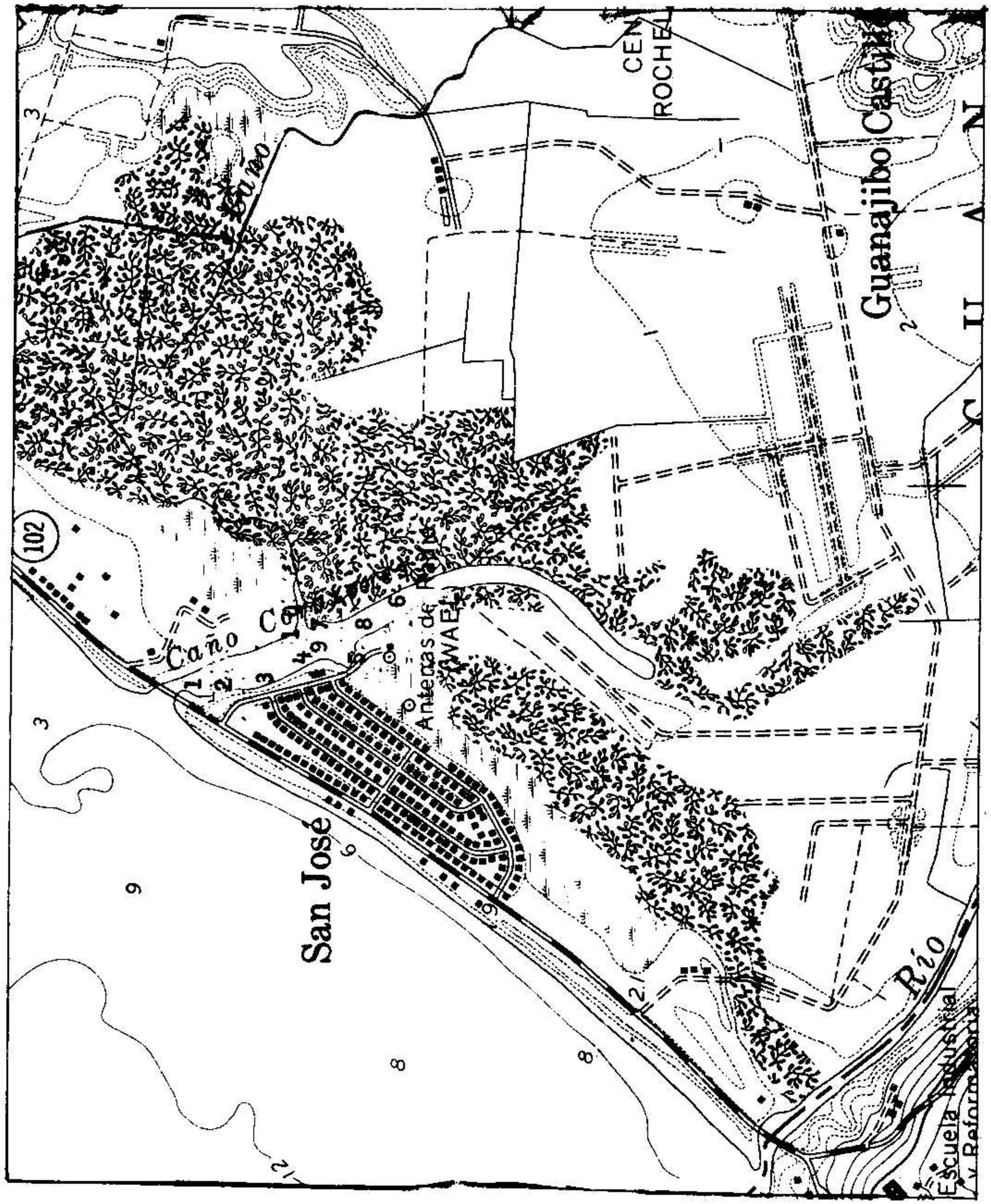

Fig. 2 Sampling Stations

(1 = I, 2 = II, 3 = III, 4 = IV, 5 = V,
6 = VI, 7 = VII, 8 = VIII, 9 = IX, 10 = X)

bridge, respectively. Station III was near the sewage treatment plant. Station IV was close to Guanajibo Homes and a radio-transmitter site. Stations V, VI and X were at the mouth of the three streams, and station VII was at the mouth of the artificial stream. Stations VIII and IX were located a few hundred feet apart, near the middle of the juncture of the three streams, as shown in Figure 2.

METHODOLOGY

Surface samples were collected from the ten stations daily from 21 July to 2 August, except for two days (23 and 30 July) when samples were not taken. All samples were collected between 8:00 AM and 10:00 AM. Total coliform levels were determined according to the technique described in "The Microbiological Analysis of Water" pp 2-8 (4), and in "Standard Methods for the Examination of Water and Waste Water" pp 610-619 (1). The biochemical oxygen demand was measured according to (1), p 415.

RESULTS AND DISCUSSION

(1) Total coliforms

The concentration of total coliforms was higher at stations I, II, III, IV and VII than at stations V, VI, VIII, IX and X. At station III the concentration was 2,000 MF/100 ml on 22 July, and 1,570,000 MF/100ml on 1 August (Table 1). During most of the period covered by this study total coliform levels were high at station III. This is possibly due to the sewage discharged from the sewage treatment plant of Guanajibo Homes. At station IV the concentration of total coliforms varied from 1,600 MF/100ml on 25 July to 36,000 MF/100ml on 21 July (Table 1). This is the station located close to Guanajibo Homes and the radio-transmitter. At station I the concentration ranged from 2,600 MF/100ml on 29 July to 140,000 MF/100ml on 1 August, and at station II the concentration varied between 6,600 MF/100ml

Table 1 Total Coliform (MF/100 ml)

	I	II	III	IV	V
July 21, 72	5,150	6,600	40,500	36,000	17,000
July 22	6,000	8,000	2,000	4,000	3,000
July 24	91,000	63,000	10,000	6,450	2,750
July 25	6,850	41,000	35,000	1,600	1,050
July 26	119,000	118,000	129,000	1,950	1,100
July 27	5,000	8,100	117,000	2,650	1,000
July 28	2,950	4,150	152,000	4,000	1,950
July 29	2,600	7,350	990,000	13,300	2,800
July 31	122,000	13,000	160,000	5,900	2,100
Aug. 1	140,000	50,000	1570,000	33,000	900
Aug. 2	10,900	91,000	110,000	5,650	3,150

Table 1 Continued (MF/100 ml)

	VI	VII	VIII	IX	X
July 21, 72	21,500	24,000	32,500	13,750	7,500
July 22	1,000	15,000	1,000	1,000	9,000
July 24	3,000	3,300	9,950	3,400	2,550
July 25	1,500	1,000	2,350	2,600	950
July 26	800	3,800	100	800	900
July 27	1,000	2,100	1,200	1,050	2,600
July 28	1,200	2,450	1,900	100	2,200
July 29	4,000	5,500	3,050	1,550	1,950
July 31	1,400	700	1,300	2,250	4,000
Aug. 1	850	900	2,800	26,000	8,750
Aug. 2	1,500	7,100	2,250	1,200	10,500

on 21 July and 118,000 MF/100ml on 26 July. These two stations were located closer to the mouth of Caño Corazones. The sewage at stations III and IV possibly flows on to stations I and II, causing the high readings. At station VII readings varied from a minimum of 700 MF/100ml on 31 July to a maximum of 7,100 MF/100ml on 2 August. With the exception of values measured on 31 July and 1 August, all readings at this last station were higher than 1,000 MF/100ml. As shown in Figure 3, the eleven day median total coliform level was 3,300 MF/100ml. This station is located where foul water from the farms enters Caño Corazones. At station V values ranged from 900 MF/100ml on 1 August to 17,000 MF/100ml on 21 July, at station VI they were from 800 MF/100ml on 26 July to 21,500 MF/100ml on 21 July, and at station X readings were from 900 MF/100ml on 26 July to 10,500 MF/100ml on 2 August. Total coliform levels were lower at these three stations, where water from the mangrove forests enters the study area, than at stations I, II, III, VI and VII. Values at station VIII ranged from 100 MF/100ml on 26 July to 32,500 MF/100ml on 21 July, and at station IX the values were from a low of 100 MF/100ml on 28 July to a high of 26,000 MF/100ml on 1 August. These results are summarized in Table 1.

During most of the period during which this study was carried out, water was seen to be flowing towards the sea. Due to the direction of water flow, higher readings were registered at stations I and II than at stations VIII and IX. Total coliform values obtained at stations I and II on July 21, 22, 27, 28 and 29 were lower than total coliform values measured on other days. It was thought that samples collected on the dates when low values were obtained might have been taken around times of high tide, so that at these particular times the water of the estuarine area was diluted with relatively clean sea water. However, this assumption is not supported

Logarithmic Paper

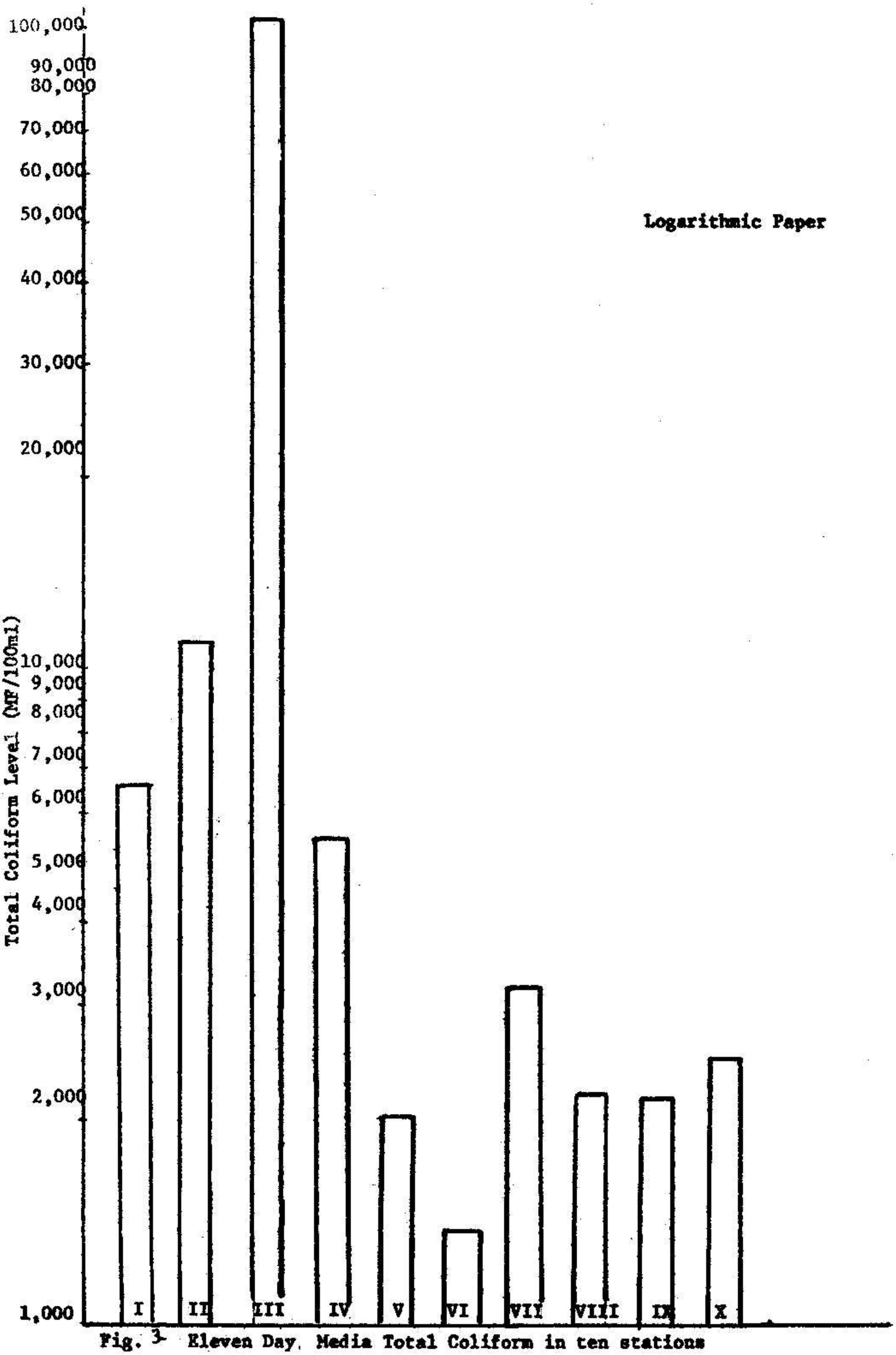

Fig. 3 Eleven Day Media Total Coliform in ten stations

by data from the Tide Tables (3).

A variance analysis of the data indicates that the difference of values registered at the ten stations at Caño Corazones is highly significant ($p<0.001$, table 3), due to distinct environmental factors and sources of sewage at each station. Eleven day media of total coliform concentration ranged from 1,400 MF/100ml at station VI to 117,000 MF/100ml at station III (Figure 3). On the basis of measurements made during this study, it is concluded that Caño Corazones is polluted by sewage, and the major source of sewage in the area is the sewage treatment facility serving Guanajibo Homes. The other source of pollution in this area is the artificial stream carrying the sewage water from the cattle farms.

(2) Biochemical oxygen demand (BOD_5)

The concentration of eleven day average BOD_5 ranged from 3.52 mg/l at station I to 7.44 mg/l at station III (Figure 4). At station III BOD_5 values ranged from 2.41 mg/l on 27 July to 12.47 mg/l on 24 July (Table 2). Water from the sewage treatment plant appears to be present at station III. Values at station V varied from 2.95 mg/l on 31 July to 8.80 mg/l on 25 July. At station IV values were between 2.48 mg/l on 27 July and 8.52 mg/l on 22 July. At station I readings ranged from 0.10 mg/l on 27 July to 6.42 mg/l on 22 July. At station II the values were from 0.82 mg/l on 27 July to 6.52 on 22 July. BOD_5 readings were usually lower at stations I and II, which are located in the estuarine portion of the study area, than at the other stations. Thus the BOD_5 values were higher in the upper part of Caño Corazones than in the lower (estuarine) portion. The values are listed in Table 2. It appears likely that in the upper reaches of the study area mangrove leaves fall into the

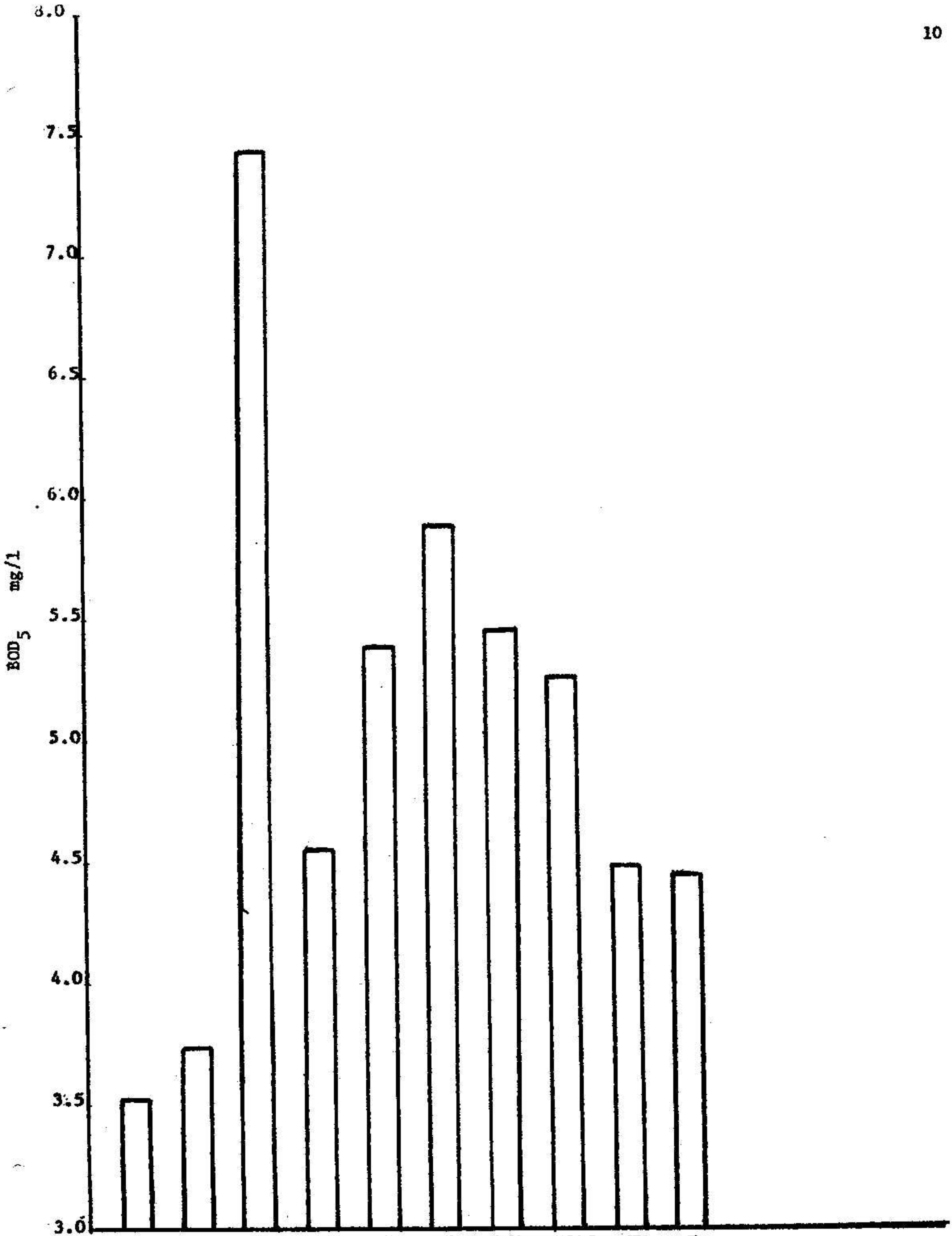

Fig.4 Eight Day Average Biochemical Oxygen Demand (BOD_5) in ten stations

Table 2 Biochemical Oxygen Demand (mg/1)

	I	II	III	IV	V
July 22, 72	6.42	6.52	6.28	8.97	7.27
July 24	5.78	5.22	12.47	6.12	6.58
July 25	5.30	5.95	5.16	5.13	8.80
July 26	3.61	3.51	7.66	5.29	3.81
July 27	0.10	0.82	2.41	0.56	3.65
July 31	1.24	1.96	11.14	3.58	2.95
Aug. 1	3.60	3.21	11.27	3.79	3.83
Aug. 2	2.08	3.09	3.10	3.00	6.19

Table 2 Continued

July 22, 72	8.52	6.22	6.70	3.79	6.73
July 24	6.83	5.88	9.00	6.37	7.70
July 25	8.09	5.42	5.79	6.36	4.79
July 26	5.47	4.62	4.94	4.41	5.08
July 27	2.48	10.64	2.14	2.56	1.17
July 31	4.61	3.23	4.07	3.73	2.28
Aug. 1	4.93	4.01	4.41	3.46	4.45
Aug. 2	5.50	3.64	5.04	5.19	3.45

water where they are decomposed by bacteria, giving higher BOD_5 readings.

Comparison of variance analysis results for total coliform and biochemical oxygen demand indicates that more highly significant differences exist in the total coliform data than in the BOD_5 data collected at the ten stations at Caño Corazones (Table 3 and 4).

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APPENDIX

Table 3 Analysis of Variance for Data of Total Coliform

Source of Variation	df	Sum of square	mean square	F
Treatments	9	844051417000	93783490777.77	3.65 **
Errors	100	2592927846500	25929278465.00	
Total SS	109	3436979263500		

** - - - - - highly significant

Table 4 Analysis of Variance for Data of Biochemical Oxygen Demand

Source of Variation	df	Sum of Squares	Mean square	F
Treatments	9	91.5447	10.1716	1.8663
Errors	70	381.5070	5.4501	
Total	79	473.0517		

Table 5 Eleven Day Media Total Coliform (MF/ml) in ten stations

I	II	III	IV	V
6850	13,000	117,000	5,650	2,100

VI	VII	VIII	IX	X
1,400	3,300	2,250	2,250	2,600

Table 6 Eight Day Average Biochemical Oxygen Demand (mg/l) in ten stations

I	II	III	IV	V
3.52	3.79	7.44	4.56	5.39

VI	VII	VIII	IX	X
5.88	5.46	5.26	4.48	4.46