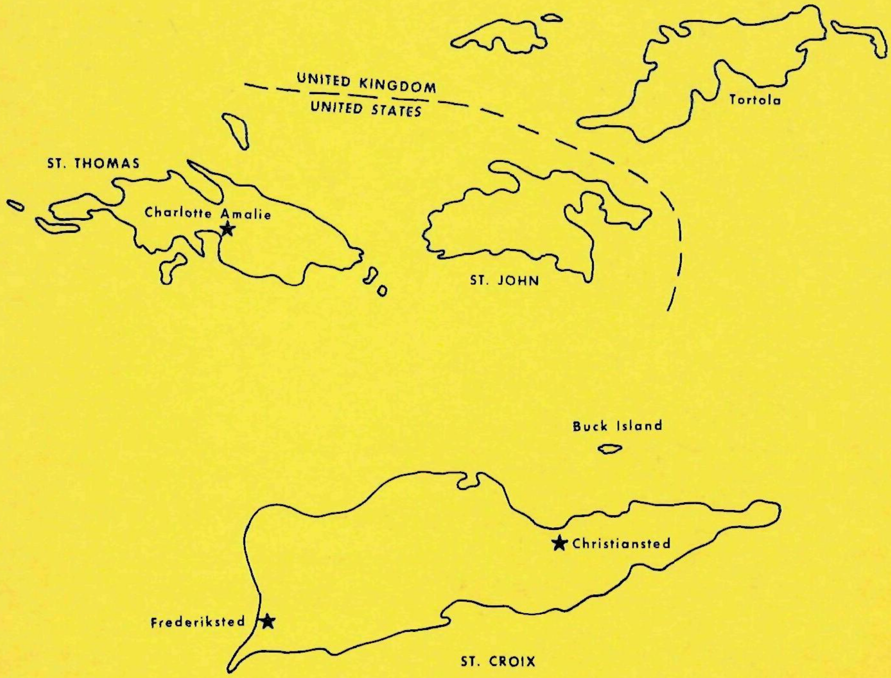
WATER QUALITY IN THE VIRGIN ISLANDS



U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II
SURVEILLANCE AND ANALYSIS DIVISION

WATER QUALITY

in the

VIRGIN ISLANDS

May 1973

United States Environmental Protection Agency
Region II
Surveillance and Analysis Division
Edison, New Jersey 08817

SUMMARY

1. The municipal dump in St. Thomas causes severe violations of standards for floating solids, dissolved oxygen, and fecal coliform bacteria.

2. Waters adjacent to municipal-industrial complexes are in the early stages of degradation. Although not severe, bacterial contamination is widespread in Charlotte Amalie and Christiansted Harbors. Water quality adjacent to the industrial complex on the south shore of St. Croix is good.

3. Outside areas of municipal and industrial development, coastal waters of the U. S. Virgin Islands exhibit good quality.

4. At 67 of 138 sampling locations background organisms were encountered which may have interfered with fecal coliform analysis by the membrane filter procedure. Since fecal coliform levels are generally low and interference was observed at a large number of locations, it is possible that fecal coliform analysis by the membrane filter procedure may not be a completely reliable indicator of fecal contamination in Virgin Islands waters. However, much further study would be required to reach final conclusions regarding this matter.

CONTENTS

WATER QUALITY SURVEY — VIRGIN ISLANDS

The United States Virgin Islands are located 1400 miles southeast of New York City and 1000 miles east of Miami, Florida. They include three main islands—St. Croix, St. Thomas and St. John, and approximately 50 smaller islands and cays (Figure 1). They are bounded on the north by the Atlantic Ocean and on the south by the Caribbean Sea. Puerto Rico lies 40 miles to the west and Tortola, British Virgin Islands, one mile to the east.

St. Thomas (12 miles long, population 28,960) is a thriving commercial and tourist center. Its life revolves around Charlotte Amalie (population 12,220), its only major city and capital of the Virgin Islands. Charlotte Amalie has one of the finest natural harbors of the Caribbean and is a popular port of call for both yachtsmen and passenger liners.

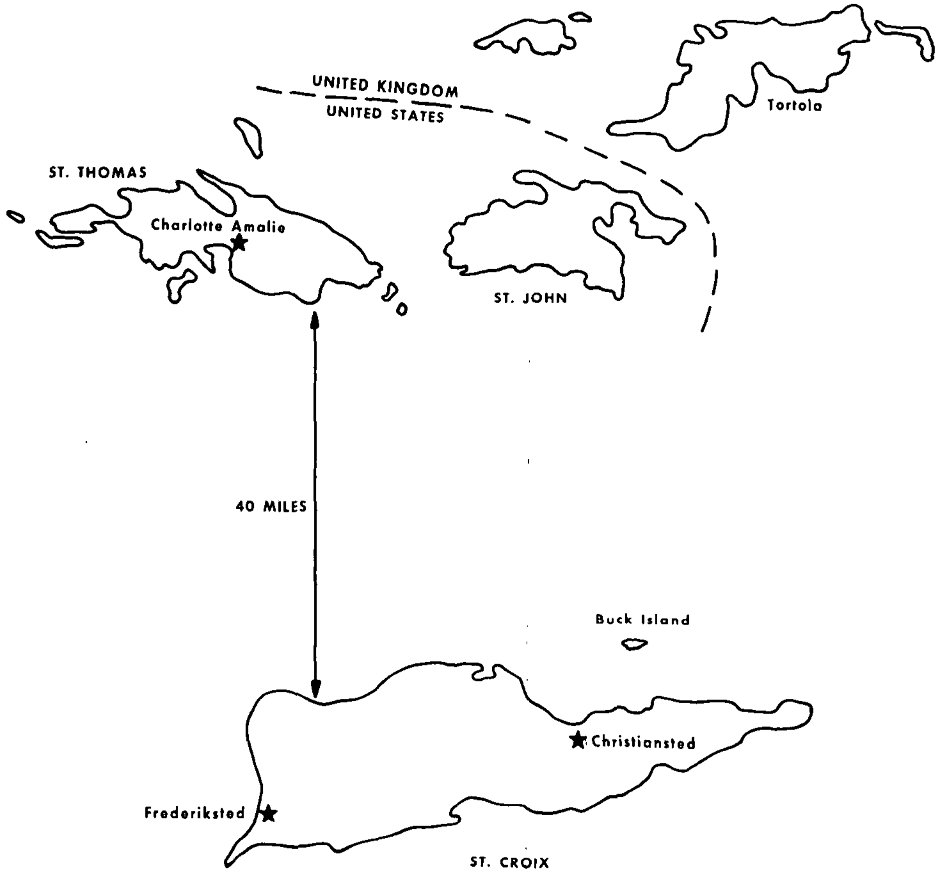
St. Croix (28 miles long, population 31,779) lies 40 miles to the south. Its major cities are Christiansted (population 3,020) and Frederiksted (population 1,531). It too is a busy commercial and tourist center and is beginning to develop industrially.

Three miles to the east of St. Thomas, lies St. John (9 miles long, population 1,729). Nearly three-quarters of its rugged mountains and most of its offshore waters have been preserved as the Virgin Islands National Park. It is famous as a water wonderland of white sand beaches, crystal clear waters, and luxuriant coral gardens.

Originally volcanic, the islands are now overlaid with limestone. All three islands have jagged, rocky shores interspersed with secluded bays and coral sand beaches. The surrounding waters are extremely clear; light easily penetrates to a depth of 100 feet. The offshore depths, which plunge nearly 2½ miles to the ocean floor, are among the best sport fishing waters of the world.

The tropical climate is unusually mild and pleasant. The temperature seldom strays more than 5 degrees from the annual average of 78°F. Rainfall averages 44 inches per year, approximately equal to that received in the eastern United States. Nearly half the average rainfall is received in four months, August through November. Rain normally falls as short, intense showers.

The combination of tropical climate, spectacular beaches and relaxed atmosphere have insured the Virgin Islands a reputation as a vacation paradise.



UNITED STATES
VIRGIN ISLANDS

Figure 1

Tourism is the major industry. The over 700,000 tourists who visit the Virgin Islands each year contribute $65,000,000 to the local economy. But this popularity has also brought growing pains. Land values are soaring. Developments and subdivisions are springing up everywhere. The resident population which in 1950 was 26,665 has already passed 60,000 on its way to 200,000 by the year 2015. Even the immigration laws have had to be relaxed to provide skilled labor.

In addition to the population increase, the Virgin Islands have also begun to expand industrially. Hess Virgin Islands Corporation has constructed a 120,000 barrel per day refinery on St. Croix. Just west of the refinery, Martin-Marietta Corporation operates a plant for converting bauxite into alumina.

Water Uses

Fresh potable water is a precious commodity in the Virgin Islands. The high evaporation, steep mountain slopes and small size of the islands prevent the formation of rivers and lakes. Little groundwater is available. Most fresh water is provided by entrapment of rainfall. For many years salt water has been used for fire protection and sanitary purposes to reduce the fresh water demand. The fresh water supply is currently being supplemented by water from desalinization plants. On each island the nonurban population procures its water from individual catchment and distribution systems.

Although fresh water is precious, the surrounding waters of the Caribbean and the Atlantic are even more vital to the island economy. They are the backbone of the predominant tourist industry. Should these waters become seriously degraded, the economy would be irreparably damaged. The Virgin Islands Legislature recognized the value of these waters by enacting stringent Water Quality Standards. These standards are summarized in Appendix A. They define best water uses and quality criteria to be met. It should be noted that they include a classification for preservation of unusually valuable natural phenomena such as the Natural Barrier Reef at Buck Island, St. Croix and the Underwater Trail at Trunk Bay, Virgin Islands National Park, St. John.

Waste Sources

The coastal waters of the Virgin Islands receive discharges of raw and inadequately treated municipal wastes, storm water runoff, treated and untreated industrial wastes, and treated domestic wastes from private resorts and developments. These discharges are summarized in Figures 2 and 3 and Appendices B, C and D.

Discharges of municipal waste are concentrated in Charlotte Amalie, Christiansted, and Frederiksted. Nearly 3.0 million gallons per day (MGD) of raw sewage is discharged into harbor waters of

WASTEWATER DISCHARGES ON ST. THOMAS & ST. JOHN

Figure 2

WASTEWATER DISCHARGES ON ST. CROIX

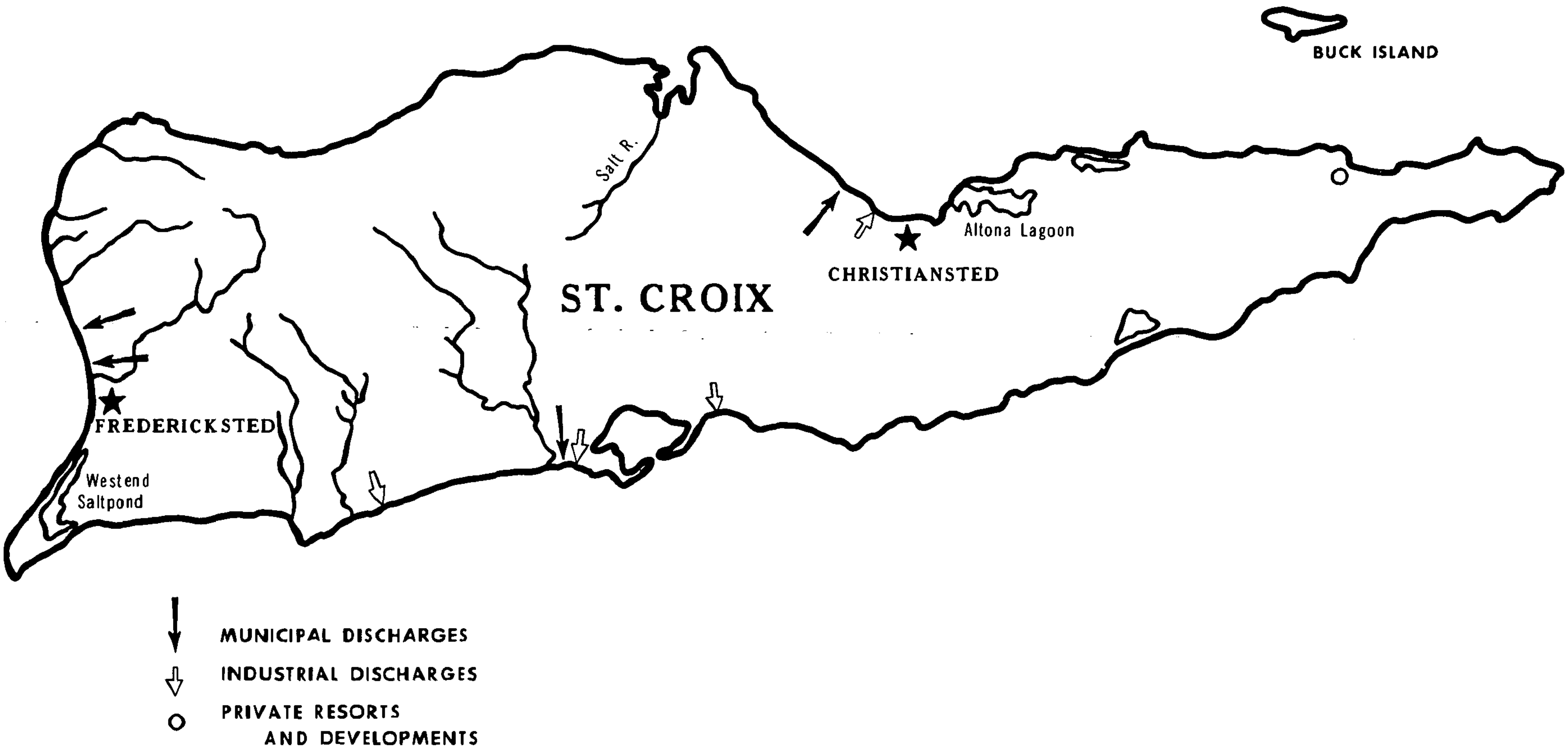


Figure 3

Charlotte Amalie. In Christiansted 1.0 MGD of raw sewage is pumped outside the harbor beyond the barrier reef. However, the main interceptor sewer is overloaded and raw sewage is discharged to the inner harbor during peak flow periods or power failures. Raw sewage (0.5 MGD) from the Frederiksted system is discharged directly into the harbor through two outfalls. Another 1.0 MGD of primary effluent is discharged to the Caribbean along the south shore of St. Croix. Municipal discharges are summarized in Appendix B.

Industrial wastes are concentrated mainly along the south shore of St. Croix. Virgin Island Rum Industries discharges 100,000 GPD of untreated beverage sediments 3,000 feet offshore in the Bettys Hope area. Martin-Marietta Alumina discharges 20 MGD of cooling water from its desalinization plant in the Krause Lagoon area. Also in the Krause Lagoon area, Hess Virgin Islands Corporation discharges 5.5 MGD of treated refinery waste and 2.2 MGD of cooling water. In Charlotte Amalie, West Indies Distilleries Limited discharges 240,000 gallons per day (GPD) of untreated waste to municipal sewers and thence to Crown Bay. The locations and nature of industrial discharges are summarized in Appendix C.

In addition to fairly large and concentrated discharges of municipal and industrial wastes, coastal waters of the Virgin Islands also receive numerous small discharges of domestic waste from private resorts and developments. These discharges are summarized in Appendix D. Most of these discharges receive secondary treatment. The patterns of recent development indicate that the number of discharges of this type will increase.

Discharge of untreated sanitary wastes from vessels is a growing problem in Frederiksted and Charlotte Amalie harbors. Each of these harbors are major ports of call for passenger liners and yachtsmen. The recent tendency toward longer stays for passenger liners and increased use by private yachtsmen are expected to increase the significance of these discharges.

The rapid development of real estate holdings has been accompanied by construction of storm water collection systems which periodically discharge nutrients, silt and bacteria. This problem is especially significant in Lindbergh Bay, St. Thomas.

<u>1972 EPA Survey</u>

The Environmental Protection Agency conducted studies of the coastal waters of the Virgin Islands from November 3 to November 27, 1972. Water samples were collected at the surface or 5-foot depth at 138 stations around St. Thomas, St. Croix and St. John. Fifty-six of the stations were located around St. Thomas, 28 around

St. John and 54 around St. Croix. The locations of the sampling stations are shown in Figures 4 and 5.

Temperature, dissolved oxygen, total coliform (membrane filter), and fecal coliform (membrane filter) levels were determined twice at each station. At some stations located in major harbors these parameters were determined three times. Total organic carbon, Kjeldahl nitrogen, nitrate nitrogen, total phosphate, copper, cadmium, zinc, aluminum, mercury, chromium and lead levels were determined once at 44 selected stations. Levels of metals in bottom sediments were also determined at 20 stations. The analytical results for all determinations are summarized in Appendix E.

Temperature and dissolved oxygen were determined on site during sample collection. Oxygen was determined by the azide modification of the Winkler method. To expedite sample collection, the first two reagents of the Winkler procedure were added immediately in the field and titration was completed at the end of daily sampling activities. Bacterial samples were collected in sterile containers and shipped via aircraft to San Juan, Puerto Rico, where bacterial analyses were performed in EPA and Puerto Rico Environmental Quality Board mobile laboratories. To avoid possible thermal shock and mortality to the bacteria, samples were not cooled following collection. The elapsed time between collection and analysis of bacterial samples averaged 6 hours. Analyses for total organic carbon, nutrients, and metals were performed at EPA laboratories in Edison, N.J. Total organic carbon samples were preserved with 5 ml/l HCl, nutrient samples with 5 ml/l H_2SO_4, and metals samples with 5 ml/l lead-free HNO_3.

Two analytical interferences were encountered during the survey. At 67 of the 138 stations background organisms, notably Pseudomonas aeruginosa, tended to proliferate on the bacteriological media and mask the fecal coliform analysis. There is a possibility that—if present—fecal coliform densities at these stations were underestimated. Since fecal coliform densities are generally low throughout the Virgin Islands and the masking effect was observed at a large number of stations, it may be possible that the fecal coliform test using the membrane filter procedure may not be a completely reliable indicator of fecal contamination in Virgin Island waters. However, much further study would be required to determine the significance of the masking effect and ascertain the reliability of the procedure. The significance of the masking effect is discussed in detail in Appendix F. Also, the naturally high sodium levels interfered with metal analysis of water samples. This interference was overcome by passing the samples through ion exchange columns prior to final metals determination. The analytical methods employed for both fecal coliform and water metals analyses are summarized in Appendices F and G. Methods for analyses of metals in sediments are summarized in Appendix H.

SAMPLING STATIONS ON ST. THOMAS & ST. JOHN

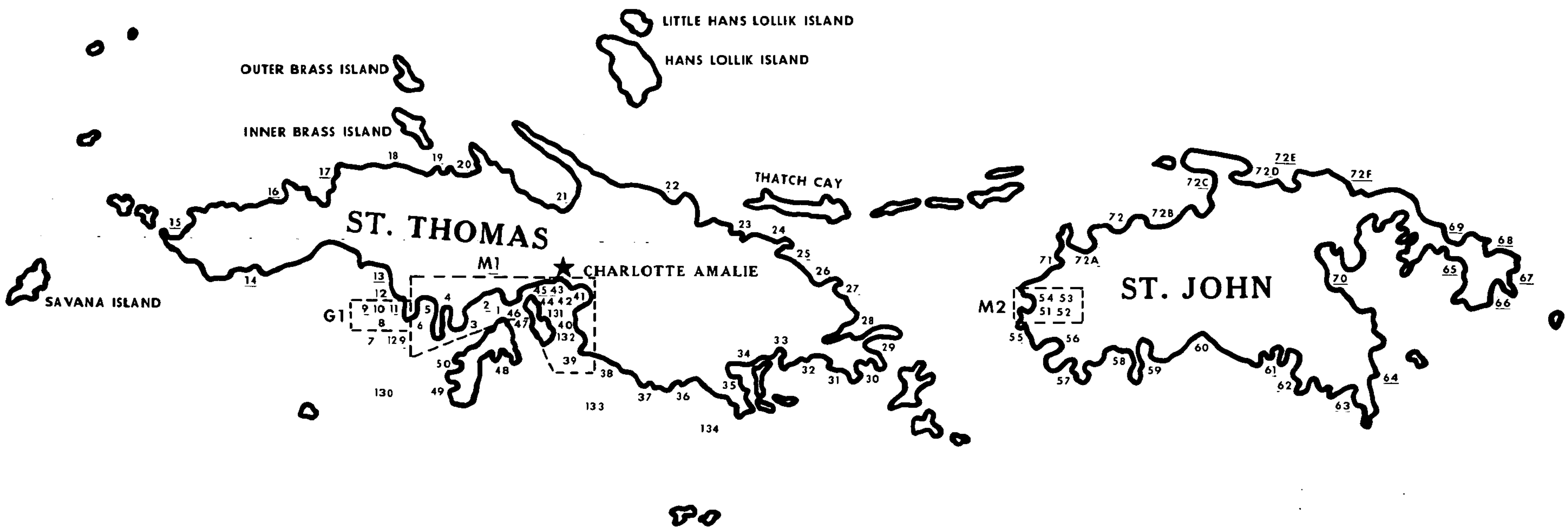


Figure 4

SAMPLING STATIONS ON ST. CROIX

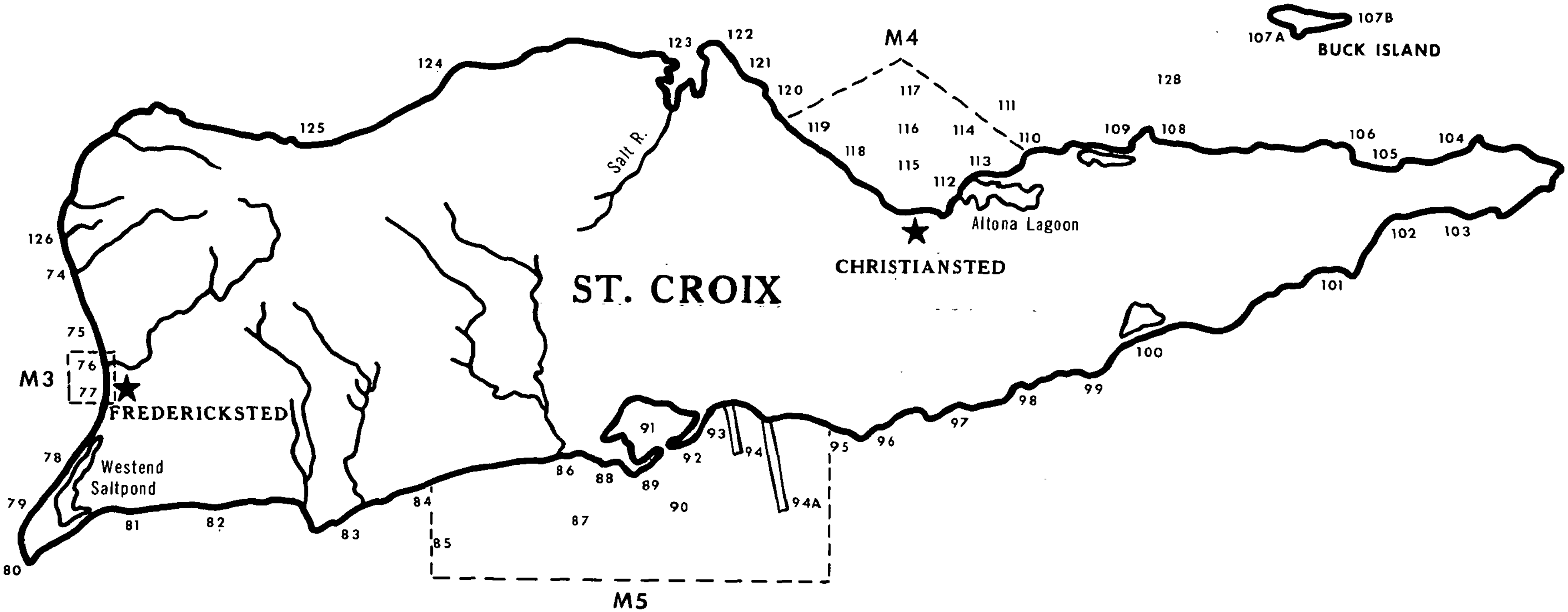


Figure 5

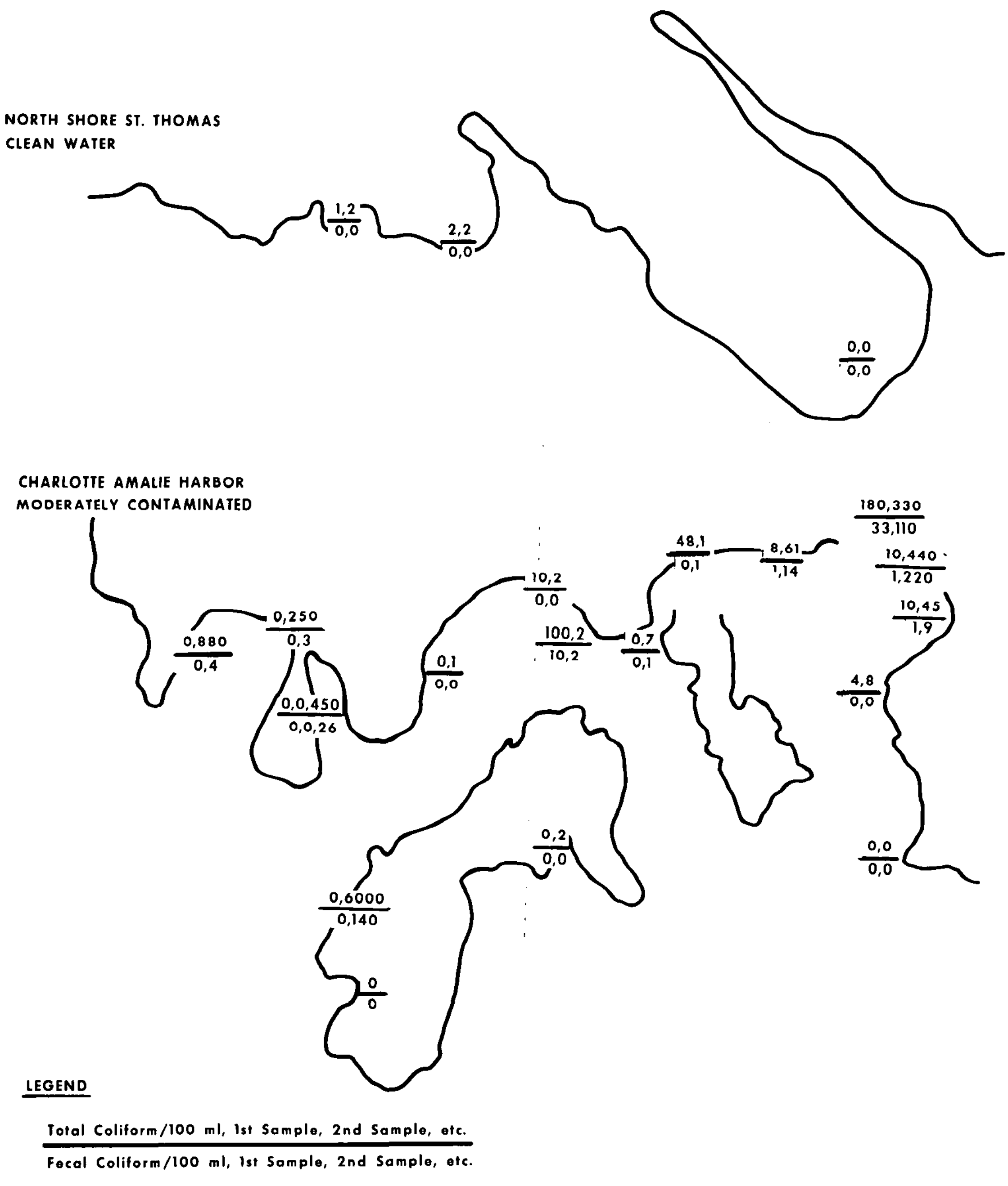
Present Water Quality

Waters of the Virgin Islands exhibit three levels of quality; severe degradation to levels which violate water quality standards; moderate contamination above background levels but below levels which would violate standards; and clean waters which exhibit no contamination. Severely degraded waters, shown as area G1 in Figure 4, include primarily those adjacent to the municipal dump in St. Thomas. Moderately contaminated waters, shown as areas M1, M2, M3, M4 and M5 of Figures 4 and 5, include primarily those waters adjacent to areas of municipal-industrial development.

The most seriously degraded waters are those adjacent to the municipal dump in the airport area of St. Thomas (stations 8, 9, 10 and 11). Water quality standards for floating solids, dissolved oxygen and fecal coliform bacteria were violated in this area. Despite the recent installation of a floating boom, these waters are severely contaminated with floating debris. Debris extends at least 50 feet beyond the boom and concentrates northwest of the landfill off the end of the airport runway. Dissolved oxygen standards were violated at all four stations. Oxygen levels varied from 3.4 to 7.5 mg/l and failed to meet standards in 5 of 12 samples. Fecal coliform levels at station 9 exceeded the median value of 70 organisms/100 ml required by the standards. Maximum fecal coliform densities of stations 8, 9, 10 and 11 were 30, 700, 46 and 1200 organisms/100 ml, respectively. *Salmonella enteritidis* ser. *senftenberg*, a human pathogenic bacterium associated with gastroenteritis, was isolated at station 9. Copper, zinc, mercury, and lead levels of bottom sediments at the dump exceeded corresponding levels in background sediments elsewhere. Bottom sediments at the dump also contained debris. Water quality in this area is summarized in Tables I and II.

Water adjacent to municipal-industrial complexes are experiencing the early effects of degradation. Although the average levels of all parameters in these areas are essentially identical to average levels in clean waters, the maximum values are generally higher. Temperature averaged 28.3°C (82.9°F). Dissolved oxygen varied from 4.7 to 8.3 mg/l. Total and fecal coliform levels were generally below 0.5 organisms/100 ml but reached maximum values of 1500 and 650 organisms/100 ml, respectively. Nitrate and total nitrogen levels averaged 0.05 and 0.45 mg/l, respectively. Total phosphate averaged .05 mg/l and total organic carbon averaged 9.7 mg/l.

The degree of contamination in moderately degraded waters is best reflected by the bacterial data. Figures 6 and 7 show the actual total and fecal coliform values for Charlotte Amalie and Christiansted Harbors plotted in the approximate location of sampling. Fecal coliform densities were above background levels in Christiansted Harbor



NORTH SHORE ST. THOMAS
CLEAN WATER
1,2 / 0,0
2,2 / 0,0
0,0 / 0,0
CHARLOTTE AMALIE HARBOR
MODERATELY CONTAMINATED
180,330 / 33,110
48,1 / 0,1
8,61 / 1,14
10,440 / 1,220
10,45 / 1,9
10,2 / 0,0
0,250 / 0,3
0,880 / 0,4
100,2 / 10,2
0,7 / 0,1
0,1 / 0,0
0,0,450 / 0,0,26
4,8 / 0,0
0,2 / 0,0
0,0 / 0,0
0,6000 / 0,140
0 / 0
LEGEND
Total Coliform/100 ml, 1st Sample, 2nd Sample, etc.
Fecal Coliform/100 ml, 1st Sample, 2nd Sample, etc.

Figure 6.

TOTAL AND FECAL COLIFORM LEVELS IN CHRISTIANSTED HARBOR

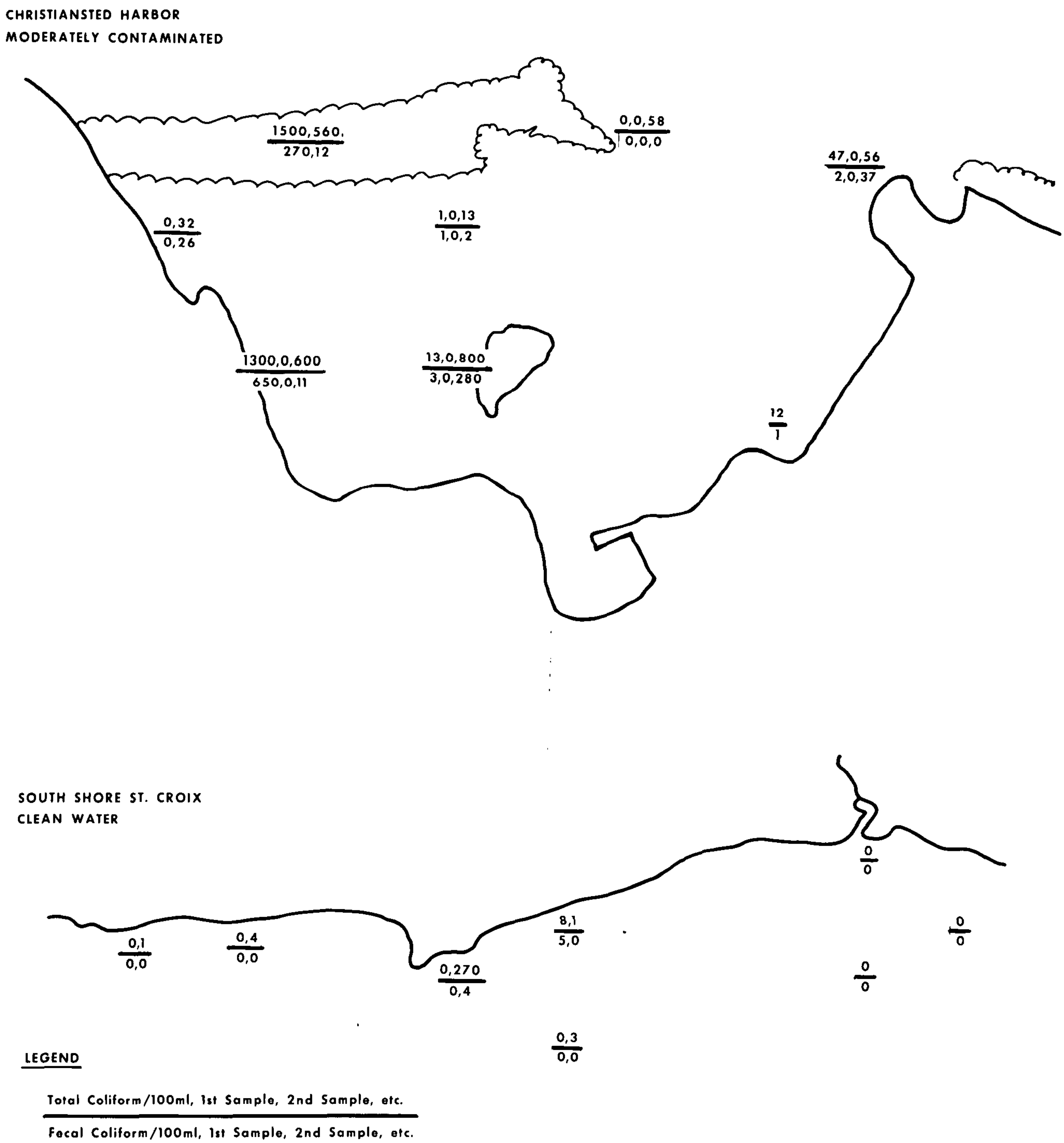


Figure 7

Table I

Water Quality Adjacent to
Municipal Dump, St. Thomas, U. S. Virgin Islands

November 14, 16, 21, 1972

Parameter and Value	Station Number 8	9	10	11
Dissolved Oxygen, mg/l	7.5, 6.2, 3.9	7.0, 3.7, 5.3	7.0, 6.6, 5.0	3.4, 6.5, 5.7
Fecal Coliform, MF/100 ml	30, 0, 28	700, 100, 65	0, 46, 23	1, 0, 1200
Total Coliform, MF/100 ml	43, 0, 390	3,400, 120, 800	1, 62, 40	1, 0, 80,000
TOC, mg/l				41
TKN, mg/l				0.70
NO_3, mg/l				< .05
T-P, mg/l				0.06
Cu, µg/l				15
Cd, µg/l				80
Zn, µg/l				180
Al, µg/l				250
Hg, µg/l				< .25
Cr, µg/l				< 30
Pb, µg/l				70

Floating Solids (Floating solids were observed at all stations at all sampling times. Standards were continually violated).

(boxed values) Water Quality Standards Violation

Salmonella enteritidis ser. *senftenberg*, a human pathogenic bacterium associated with gastroenteritis, was isolated at Station 9.

Table II

Metals Levels in Sediments Adjacent to
Municipal Dump, St. Thomas, U. S. Virgin Islands

Parameter and Value	Location	
	Mean Level* at Background Stations	Levels* Adjacent to Dump, Station 11
Cu, mg/kg	12.8	103
Cd, mg/kg	9.3	9.8
Zn, mg/kg	17.6	540
Hg, mg/kg	0.014	0.15
Cr, mg/kg	8.0	31.7
Pb, mg/kg	37.9	352.0

*Based on dry weight

both inside and outside the reef (stations 118 and 117). General patterns of elevated bacterial levels were observed in both Charlotte Amalie and Christiansted Harbors. Fecal coliforms were often detected repetitively at the same location. In Charlotte Amalie fecal coliform densities varied from less than one to 220 organisms/100 ml. Slightly elevated fecal coliform densities were also observed in: Honeymoon Bay, St. Thomas; Cruz Bay, St. John and Prune Bay, St. Croix.

Water quality adjacent to the industrial complex on the south shore of St. Croix is presently good. Average values for all water quality parameters in this area are approximately equal to average values observed in clean waters elsewhere. Levels of most parameters also fall within the ranges observed elsewhere.

Those waters outside areas of municipal and industrial development are generally clean. Quality of these waters is essentially identical around all three islands. Temperature averaged 28.2°C (82.8°F). Dissolved oxygen varied from 4.4 to 8.9 mg/l. The mean dissolved oxygen level of 6.8 mg/l was well within the 5.5 mg/l required by the approved Federal-state Water Quality Standards. In Trunk Bay, St. John—where the standards require maintenance of natural conditions—the dissolved oxygen level was 6.5 mg/l. The prevailing total and fecal coliform levels were below 0.5 organisms per 100 ml. Nitrate and total nitrogen levels averaged 0.05 and 0.33 mg/l, respectively. Total phosphate averaged 0.07 mg/l and total organic carbon averaged 9.7 mg/l. Dissolved copper, cadmium, chromium and lead levels were less than 100 µg/l. Zinc and aluminum levels were approximately 300 µg/l. Mercury averaged only 0.23 µg/l. Average levels of copper, cadmium, zinc, chromium, lead and mercury in bottom sediments were 13.5, 13.1, 20.0, 7.6, 38.4 and 0.022 mg/kg, respectively (based on dry weight).

APPENDIX A

Subchapter 186.	Water Quality Standards for Coastal Waters of the Virgin Islands
Authority:	12 V.I.C. Section 186

Sections:

186-1 Minimum Required Conditions

186-2 Class A

186-3 Class B

186-4 Class C

186-5 Anti-degradation

186-6 Analytical procedures

186-7 Applicability of standards

186-8 Natural waters

186-9 Legal limits

Section 186-1 Minimum Required Conditions

(a) Free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits.

(b) Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges.

(c) Free from materials attributable to municipal, industrial or other discharges producing color, turbidity, odor, taste (either of itself or in the biota) or other conditions in such degree as to interfere with any legitimate water uses.

(d) Free from substances attributable to municipal, industrial or other discharges in concentrations or combinations which are toxic or harmful to human, animal, or aquatic life.

Section 186-2 Class A

(a) Best usage of waters: Preservation of Natural Phenomena requiring special conditions, such as the Natural Barrier Reef at Buck Island, St. Croix and the Under Water Trail at Trunk Bay, St. John.

(b) Quality Criteria

Existing conditions shall not be changed.

Section 186-3 Class B

(a) Best usage of waters: For Propagation of Marine Life and for Water Contact Recreation.

(b) Quality Criteria

(1) Dissolved oxygen: Not less than 5.5 mg/l.

(2) pH: No values below 7.0 nor above 8.5.

(3) Temperature: Not to exceed 90° at any time nor as a result of waste discharges to be more than 4°F above natural during fall, winter and spring nor 1.5°F above natural during summer.

(4) Bacteria: Fecal coliform density shall not be greater than 70 per 100 milliliters as a monthly median value by MF count.

Section 186-4 Class C

(a) Best usage of water: For Harbors and Docking Facilities.

(b) Quality Criteria

The following criteria are applicable at any point in the harbor except for areas immediately adjacent to outfalls or drainage ditches. In such areas recognition will be given to opportunities for the admixture of waste effluent with harbor waters.

(1) Dissolved oxygen: Not less than 5.0 mg/l.

(2) pH: No value below 6.5 nor above 8.5.

(3) Temperature: Not to exceed 90°F at any time nor as a result of waste discharges to be more than 4°F above natural during fall, winter, and spring nor 1.5°F above natural during summer.

(4) Bacteria: Fecal coliform shall not be greater than 1,000 per 100 milliliters as a monthly median value by MF count.

Section 186-5 Anti-Degradation

Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at their existing high quality. These and other waters of the Virgin Islands will not be lowered in quality unless and until it has been affirmatively demonstrated to the Territory's water pollution control agency and the Department of the

Interior that such change is justifiable as a result of necessary economic or social development and will not interfere with or become injurious to any assigned uses made of, or presently possible in such waters. Any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters will be required, as part of the initial project design, to provide the highest and best practicable degree of waste treatment available under existing technology, and since these are also Federal standards, these waste treatment requirements will be developed cooperatively.

Section 186-6 Analytical Procedures

The analytical procedures used as methods of analysis to determine the chemical, bacteriological, biological, and radiological quality of water samples shall be in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater" or other methods approved by the Virgin Islands Department of Health and the Federal Water Pollution Control Administration.

Section 186-7 Applicability of Standards

The preceding criteria will be applicable to all Virgin Islands coastal waters at all places and at all times.

Section 186-8 Natural Waters

Natural waters may, on occasion, have characteristics outside of the limits prescribed by those criteria. The criteria contained herein do not relate to a violation of standards resulting from natural forces.

Section 186-9 Legal Limits

(a) Class "A" (Natural Phenomena)

(1) Within 0.5 miles of the boundaries of Buck Island Natural Barrier Reef, St. Croix.

(2) Trunk Bay, St. John.

(b) Class "B" (Marine Life and Water Contact Recreation)

(1) All other coastal waters not classified Class "A" or Class "C".

(c) Class "C" (Harbors)

(1) St. Thomas

(A) St. Thomas Harbor beginning at Rupert Rock and extending to Haulover Cut.

(B) Crown Bay enclosed by a line from Hassel Island at Haulover Cut to Regis Point at West Gregaria Channel.

(C) Krum Bay.

(2) St. Croix.

(A) Christiansted Harbor from Fort Louise Augusta to Golden Rock.

(B) Frederiksted Harbor from La Grange to Fisher Street.

APPENDIX B

MUNICIPAL WASTEWATER DISCHARGES IN THE VIRGIN ISLANDS

Municipality	Population	Treatment	Flow, MGD	Receiving Water
St. Thomas				
Charlotte Amalie	24,000	None	3.0	St. Thomas Harbor
Lindbergh Bay	4,000	None	0.4	Southwest Road
St. John				
Cruz Bay	1,000	Primary	0.015	Cruz Bay Creek
St. Croix				
Krause Lagoon	10,000	Primary	1.00	South Shore
Frederiksted	5,000	None	0.50	Frederiksted Harbor
Christiansted	10,000	None	1.00	Outside Christiansted Harbor

APPENDIX C

INDUSTRIAL WASTEWATER DISCHARGES IN THE VIRGIN ISLANDS

Industry	Waste Characteristics	Treatment	Flow, MGD	Receiving Water
St. Thomas				
West Indies Distilleries, Ltd.	High BOD, suspended solids.	None, discharge to municipal sewer.	0.24	St. Thomas Harbor
Virgin Is. Power & Water Auth.	High temp. cooling water.	None.	37.5	Lindbergh Bay
St. Croix				
Virgin Is. Rum Industries	High BOD, suspended solids.	None.	0.10	South Shore
Hess Virgin Is. Corp.	High temp., oil.	API Separators, screening equalization for process waters. No treatment of cooling water.	2.0 cooling 5.5 process	South Shore
Martin-Marietta Corp.	High temp., high pH, suspended solids.	Settling ponds for process waste. No treatment of cooling water.	20.0	South Shore
Virgin Is. Power & Water Auth.	High temp. cooling water.	None	10.0	Christiansted Harbor

APPENDIX D

DISCHARGES FROM PRIVATE RESORTS AND DEVELOPMENTS

Location	Treatment	Flow, GPD	Receiving Water
St. Thomas			
Bon Ami	Secondary	25,000	Hull Bay
Pineapple Beach	Secondary	45,000	Water Bay
Sapphire Bay	Secondary	50,000	Marina Pond
Secret Harbor	Secondary	25,000	Nazareth Bay
FAA Lindbergh Bay	Secondary	10,000	Southwest Road
St. Croix			
Wave-Cane Bay	Secondary	1,500	Shore Waters

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	WATER TEMP CENT 00010	DO MG/L 00300	NO3-N MG/L 00620	T KJL N MG/L 00625	PHS-T P-WET MG/L 00665	T ORG C MG/L 00680	COLIF MFFC 100ML 31616	COLIF MFTC 100ML 31501
VI-1	11-13-72	1430	005	25109	28.5	7.4	N	N	N	N	10B	100B
VI-1	11-16-72	1245	000	25194	N	6.5	0.05K	0.71	0.05K	15.0	0	2
VI-2	11-13-72	1434	005	25110	28.4	7.1	N	N	N	N	0	10B
VI-2	11-16-72	1240	000	25193	N	6.6	N	N	N	N	0	2
VI-3	11-13-72	1438	005	25111	28.4	6.7	N	N	N	N	0	0
VI-3	11-16-72	1228	000	25192	N	6.1	0.05K	0.73	0.05K	7.0	0	1
VI-4	11-14-72		005	25147	27.6	7.3	N	N	N	N	26	450
VI-4	11-16-72	1224	000	25191	N	6.5	N	N	N	N	0	0
VI-4	11-21-72	1048	005	25273	N	6.4	N	N	N	N	0	0
VI-5	11-14-72		005	25146	27.9	6.8	N	N	N	N	3	250
VI-5	11-16-72	1216	000	25190	N	6.6	N	N	N	N	0	0
VI-6	11-14-72		005	25145	27.8	8.3	N	N	N	N	4	880
VI-6	11-16-72	1215	000	25189	N	6.6	N	N	N	N	0	0
VI-7	11-14-72		005	25144	27.8	7.0	N	N	N	N	0	36
VI-7	11-16-72	1445	000	25201	N	6.4	0.05K	0.65	0.08	5.5	0	0
VI-8	11-14-72		005	25143	27.7	7.5	N	N	N	N	28	390
VI-8	11-16-72	1436	000	25200	N	6.2	N	N	N	N	30	43
VI-8	11-21-72	1127	005	25274	N	3.9	N	N	N	N	0	0
VI-9	11-14-72		005	25142	27.6	7.0	N	N	N	N	65	800
VI-9	11-16-72	1434	000	25199	N	3.7	N	N	N	N	700	3400
VI-9	11-21-72	1125	005	25275	N	5.3	N	N	N	N	100	120
VI-10	11-14-72		005	25141	27.5	7.0	N	N	N	N	23	400
VI-10	11-16-72	1430	000	25198	N	6.6	0.05K	0.70	0.06	41.0	0	1
VI-10	11-21-72	1118	005	25277	N	5.0	N	N	N	N	46	62
VI-11	11-14-72		005	25140	27.6	3.4	N	N	N	N	1200B	80000B
VI-11	11-16-72	1424	000	25197	N	6.5	N	N	N	N	1	1
VI-11	11-21-72	1115	005	25279	N	5.7	N	N	N	N	0	0
VI-12	11-14-72		005	25139	27.6	7.0	N	N	N	N	3	49
VI-12	11-16-72	1412	000	25196	N	6.1	0.05K	0.81	0.05K	5.0	1	24
VI-13	11-14-72		005	25138	27.8	8.0	N	N	N	N	75	1600B
VI-13	11-16-72	1400	000	25195	N	7.6	N	N	N	N	0	0
VI-13	11-21-72	1135	005	25281	N	6.9	N	N	N	N	0	0
VI-14	11-14-72		005	25137	27.8	7.3	N	N	N	N	0	48
VI-14	11-17-72	1450	000	25225	N	6.5	N	N	N	N	0	0
VI-15	11-14-72		005	25136	27.9	7.5	N	N	N	N	0	15
VI-15	11-17-72	1430	000	25224	N	7.0	N	N	N	N	0	0
VI-16	11-14-72		005	25135	27.8	7.0	N	N	N	N	77	1600B
VI-16	11-17-72	1416	000	25223	N	6.7	0.05K	0.29	0.05K	2.3	0	0
VI-17	11-14-72		005	25134	28.2	8.2	N	N	N	N	N	1100
VI-17	11-17-72	1410	000	25222	N	7.2	N	N	N	N	0	0
VI-18	11-14-72		005	25133	28.2	7.6	N	N	N	N	24	1600B
VI-18	11-17-72	1406	000	25221	N	7.2	N	N	N	N	0	0
VI-19	11-14-72		005	25132	28.1	8.3	N	N	N	N	0	2
VI-19	11-17-72	1348	000	25220	N	6.7	0.05K	0.30	0.05K	1.0	0	1
VI-20	11-14-72		005	25131	28.6	4.5	N	N	N	N	0	2
VI-20	11-17-72	1345	000	25219	N	7.3	N	N	N	N	0	2
VI-21	11-14-72	1210	000	25130	N	6.7	N	N	N	N	0	0
VI-21	11-17-72	1332	000	25218	N	5.8	0.05K	0.28	0.05K	1.4	0	0
VI-22	11-14-72	1155	000	25129	N	6.8	N	N	N	N	0	0
VI-22	11-17-72	1235	000	25217	N	7.3	N	N	N	N	0	0
VI-23	11-14-72	1130	000	25128	N	7.2	N	N	N	N	0	0

REMARKS-
B=COLONY COUNT OUTSIDE ACCEPTABLE RANGE, C=CALCULATED VALUE, J=ESTIMATED VALUE, K=LESS THAN, L=GREATER THAN,
M=NEGATIVE VALUE, N=NO DATA AVAILABLE

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	WATER TEMP CENT 00010	DO MG/L 00300	NO3-N MG/L 00620	T KJL N MG/L 00625	PHS-T P-WET MG/L 00665	T ORG C MG/L 00680	COLIF MFFC 100ML 31616	COLIF MFTC 100ML 31501
VI-23	11-17-72	1226	000	25216	N	6.7	N	N	N	N	0	0
VI-24	11-14-72	1120	000	25127	N	6.8	N	N	N	N	0	0
VI-24	11-17-72	1222	000	25215	N	6.3	N	N	N	N	0	1
VI-25	11-14-72	1110	000	25126	N	6.7	N	N	N	N	0	0
VI-25	11-17-72	1217	000	25214	N	6.0	N	N	N	N	0	0
VI-26	11-14-72	1100	000	25125	N	6.6	N	N	N	N	0	0
VI-26	11-17-72	1210	000	25213	N	6.9	N	N	N	N	0	0
VI-27	11-14-72	1055	000	25124	N	6.0	N	N	N	N	0	0
VI-27	11-17-72	1203	000	25212	N	6.1	0.05K	0.45	0.05K	1.1	0	0
VI-28	11-17-72	1156	000	25210	N	6.3	N	N	N	N	0	0
VI-28	11-17-72	1157	000	25211	N	N	N	N	N	N	0	2
VI-29	11-14-72	1045	000	25123	N	6.4	N	N	N	N	0	0
VI-29	11-17-72	1145	000	25209	N	6.3	N	N	N	N	0	0
VI-30	11-14-72	1042	000	25122	N	6.1	N	N	N	N	0	0
VI-30	11-17-72	1134	000	25376	N	6.3	N	N	N	N	0	0
VI-31	11-14-72	1040	000	25121	N	7.1	N	N	N	N	0	0
VI-31	11-17-72	1120	000	25208	N	5.9	0.05K	0.31	0.05K	3.0	0	1
VI-32	11-14-72	1035	000	25120	N	6.5	N	N	N	N	0	0
VI-32	11-17-72	1117	000	25207	N	6.3	N	N	N	N	0	0
VI-33	11-14-72	1030	000	25119	N	6.5	N	N	N	N	0	0
VI-33	11-17-72	1025	000	25205	N	5.1	N	N	N	N	2	21
VI-34	11-14-72	1020	000	25118	N	6.7	N	N	N	N	0	0
VI-34	11-17-72	1043	000	25206	N	5.6	0.12	0.23	0.05K	3.0	11	240
VI-35	11-14-72	1015	000	25117	N	5.9	N	N	N	N	0	8
VI-36	11-14-72	0940	005	25116	N	6.2	N	N	N	N	0	0
VI-36	11-17-72	0932	000	25204	N	6.1	N	N	N	N	0	5
VI-37	11-14-72	0922	005	25115	N	6.2	N	N	N	N	0	0
VI-37	11-17-72	0920	000	25203	N	5.6	N	N	N	N	0	0
VI-38	11-14-72	0915	005	25114	N	6.6	N	N	N	N	0	0
VI-38	11-17-72	0915	000	25202	N	6.0	N	N	N	N	1	62
VI-39	11-13-72	1335	005	25101	28.5	7.4	N	N	N	N	0	0
VI-39	11-16-72	1013	000	25177	N	6.7	0.05K	0.51	0.05K	7.0	0	0
VI-40	11-13-72	1350	005	25102	28.5	7.0	N	N	N	N	0	4
VI-40	11-16-72	1018	000	25178	N	6.2	0.05K	0.61	0.05K	5.0	0	8
VI-41	11-13-72	1356	005	25103	28.2	7.3	N	N	N	N	1	10
VI-41	11-16-72	1032	000	25179	28.6	5.7	0.05K	0.64	0.06	4.5	9	45
VI-42	11-13-72	1402	005	25104	28.5	7.4	N	N	N	N	1	108
VI-42	11-16-72	1038	000	25180	28.5	6.0	N	N	N	N	200	440
VI-43	11-13-72	1405	005	25105	28.7	8.2	N	N	N	N	33	180
VI-43	11-16-72	1042	000	25181	28.6	6.4	0.05K	0.69	0.05K	4.0	100	320
VI-44	11-13-72	1407	005	25106	28.4	7.1	N	N	N	N	1	8
VI-44	11-16-72	1050	000	25182	28.9	5.7	N	N	N	N	14	61
VI-45	11-13-72	1413	005	25107	28.4	7.1	N	N	N	N	0	48
VI-45	11-16-72	1055	000	25183	29.0	6.9	0.05K	0.63	0.05K	7.0	1	1
VI-46	11-13-72	1428	005	25108	28.4	7.3	N	N	N	N	0	0
VI-46	11-16-72	1110	000	25184	28.7	6.5	N	N	N	N	1	7
VI-47	11-13-72	1510	005	25113	29.1	8.5	N	N	N	N	0	0
VI-47	11-16-72	1115	000	25185	28.3	6.8	N	N	N	N	0	1
VI-48	11-13-72	1450	005	25112	28.6	7.5	N	N	N	N	0	0
VI-48	11-16-72	1131	000	25186	N	7.2	N	N	N	N	0	2
VI-49	11-16-72	1152	000	25187	N	5.8	N	N	N	N	0	0

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	WATER TEMP CENT 00010	DO MG/L 00300	NO3-N MG/L 00620	T KJL N MG/L 00625	PHS-T P-WET MG/L 00665	T ORG C MG/L 00680	COLIF MFFC 100ML 31616	COLIF MFTC 100ML 31501
VI-50	11-14-72		005	25148	28.5	7.7	N	N	N	N	140	6000
VI-50	11-16-72	1200	000	25188	N	7.0	N	N	N	N	0	0
VI-51	11-15-72	1126	000	25152	N	6.2	N	N	N	N	0	0
VI-51	11-18-72	0852	000	25229	27.8	5.0	0.05K	0.38	0.05K	N	0	0
VI-52	11-15-72	1125	000	25151	N	5.5	N	N	N	N	110	400
VI-52	11-18-72	0848	000	25228	28.1	6.0	N	N	N	N	2	40
VI-53	11-15-72	1120	000	25149	N	5.2	N	N	N	N	1	2
VI-53	11-18-72	0840	000	25226	28.0	5.5	0.05K	0.36	0.05K	N	0	0
VI-54	11-15-72	1124	000	25150	N	5.9	N	N	N	N	0	0
VI-54	11-18-72	0843	000	25227	28.0	5.8	N	N	N	N	0	0
VI-55	11-15-72	1523	000	25176	N	7.4	N	N	N	N	0	0
VI-55	11-18-72		000	25249	29.5	8.9	0.05K	0.28	0.23	5.8	0	0
VI-56	11-15-72	1517	000	25175	N	7.0	N	N	N	N	0	0
VI-57	11-15-72	1509	000	25174	N	7.0	N	N	N	N	0	0
VI-58	11-15-72	1500	000	25173	N	7.2	N	N	N	N	0	0
VI-59	11-15-72	1440	000	25172	N	6.7	N	N	N	N	0	0
VI-59	11-18-72	1236	000	25248	29.2	7.1	0.05K	0.29	0.05K	24.0	0	0
VI-60	11-15-72	1439	000	25171	N	8.9	N	N	N	N	0	0
VI-61	11-15-72	1430	000	25170	N	7.3	N	N	N	N	0	0
VI-61	11-18-72	1231	000	25247	28.8	7.0	N	N	N	N	0	0
VI-62	11-15-72	1425	000	25169	N	6.9	N	N	N	N	0	0
VI-62	11-18-72	1225	000	25246	28.6	7.3	0.05K	0.26	0.05K	N	0	0
VI-63	11-15-72	1400	000	25168	N	7.3	N	N	N	N	0	0
VI-63	11-18-72	1145	000	25245	28.4	6.8	N	N	N	N	0	0
VI-64	11-15-72	1335	000	25167	N	6.7	N	N	N	N	0	0
VI-64	11-18-72		000	25244	28.9	6.7	N	N	N	N	0	0
VI-65	11-15-72	1310	000	25165	N	7.2	N	N	N	N	0	0
VI-65	11-18-72	1103	000	25242	28.4	6.4	N	N	N	N	0	0
VI-66	11-15-72	1302	000	25164	N	6.8	N	N	N	N	0	0
VI-66	11-18-72	1040	000	25241	28.0	6.4	N	N	N	N	0	0
VI-67	11-15-72	1258	000	25163	N	6.8	N	N	N	N	0	0
VI-67	11-18-72		000	25240	28.0	6.2	0.05K	0.60	0.05K	24.0	0	0
VI-68	11-15-72	1255	000	25162	N	6.8	N	N	N	N	0	0
VI-68	11-18-72	1018	000	25239	28.0	6.4	N	N	N	N	0	0
VI-69	11-15-72	1245	000	25161	N	7.3	N	N	N	N	0	0
VI-69	11-18-72	1012	000	25238	28.0	6.7	N	N	N	8.1	0	0
VI-70	11-15-72	1320	000	25166	N	7.4	N	N	N	N	0	0
VI-70	11-18-72	1117	000	25243	28.9	6.7	0.05K	0.31	0.05K	1.3	0	0
VI-71	11-15-72	1132	000	25153	N	6.4	N	N	N	N	0	0
VI-71	11-18-72	0901	000	25230	27.9	6.9	0.05K	0.25	0.31	N	0	0
VI-72	11-15-72	1146	000	25155	N	6.5	N	N	N	N	0	0
VI-72	11-18-72	0919	000	25232	27.9	6.1	N	N	N	N	0	0
VI-72A	11-15-72	1140	000	25154	N	6.5	N	N	N	N	0	0
VI-72A	11-18-72	0911	000	25231	27.9	6.5	N	N	N	N	0	0
VI-72B	11-15-72	1152	000	25156	N	6.6	N	N	N	N	0	0
VI-72B	11-18-72	0927	000	25233	27.8	4.4	0.05K	0.29	0.05K	1.7	0	0
VI-72C	11-15-72	1201	000	25157	N	7.0	N	N	N	N	0	0
VI-72C	11-18-72	0938	000	25234	28.1	6.6	0.05K	0.35	0.05K	24.0	0	0
VI-72D	11-15-72	1215	000	25158	N	6.6	N	N	N	N	0	0
VI-72D	11-18-72	0947	000	25235	27.8	6.3	N	N	N	N	0	0
VI-72E	11-15-72	1220	000	25159	N	6.7	N	N	N	N	0	0

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	WATER TEMP CENT 00010	DO MG/L 00300	NO3-N MG/L 00620	T KJL N MG/L 00625	PHS-T P-WET MG/L 00665	T ORG C MG/L 00680	COLIF MFFC 100ML 31616	COLIF MFTC 100ML 31501
VI-72E	11-18-72	0954	000	25236	28.0	6.5	N	N	N	N	0	0
VI-72F	11-15-72	1232	000	25160	N	7.1	N	N	N	N	0	0
VI-72F	11-18-72	1003	000	25237	28.0	6.5	N	N	N	N	0	0
VI-74	11-21-72	1110	000	25304	N	6.6	N	N	N	N	0	0
VI-74	11-24-72	1145	005	25365	N	N	N	N	N	N	0	52
VI-75	11-21-72	1105	000	25303	N	N	N	N	N	N	0	0
VI-75	11-24-72	1135	005	25364	N	6.3	N	N	N	N	0	6
VI-76	11-21-72	1058	000	25302	N	6.7	0.05K	0.23	0.05K	18.0	1	1
VI-76	11-24-72	1133	005	25363	N	6.6	0.05K	0.16	0.05K	13.0	0	4
VI-77	11-21-72	1055	000	25301	N	7.1	N	N	N	N	17	17
VI-77	11-24-72	1130	005	25362	N	7.0	0.05K	0.23	0.05K	6.0	0	0
VI-78	11-21-72	1045	000	25300	N	N	N	N	N	N	0	0
VI-78	11-24-72	1120	005	25361	N	6.5	N	N	N	N	0	1
VI-80	11-21-72	1040	000	25299	N	6.9	N	N	N	N	0	0
VI-80	11-24-72	1110	005	25360	N	6.7	N	N	N	N	0	0
VI-81	11-21-72	1032	000	25298	N	N	N	N	N	N	0	0
VI-81	11-24-72	1100	005	25359	N	6.5	N	N	N	N	0	1
VI-82	11-21-72	1025	000	25297	N	5.9	N	N	N	N	0	0
VI-82	11-24-72	1055	005	25358	N	7.2	N	N	N	N	0	4
VI-83	11-21-72	1020	000	25296	N	6.5	N	N	N	N	0	0
VI-83	11-24-72	1050	005	25357	N	5.7	N	N	N	N	4	270
VI-84	11-21-72	1015	000	25295	N	N	N	N	N	N	5	8
VI-84	11-24-72	1045	005	25356	N	6.4	N	N	N	N	0	1
VI-85	11-21-72	1010	000	25294	N	6.1	N	N	N	4.0	0	0
VI-85	11-24-72	1035	005	25355	N	6.1	N	N	N	N	0	3
VI-86	11-21-72	0955	000	25293	N	5.4	0.07	0.48	0.05K	26.0	0	0
VI-87	11-21-72	0947	000	25292	N	7.2	0.05K	0.23	0.08	N	0	0
VI-87	11-24-72	1005	005	25353	N	5.9	0.05K	0.60	0.05K	5.0	N	N
VI-89	11-21-72	0935	000	25291	N	6.5	N	N	N	N	0	0
VI-90	11-21-72	0928	000	25290	N	6.6	N	N	N	N	0	12
VI-91	11-21-72	0924	000	25289	N	5.8	N	N	N	N	0	0
VI-92	11-21-72	0920	000	25288	N	6.4	N	N	N	N	0	2
VI-93	11-20-72	1145	000	25273	N	6.9	N	N	N	N	0	0
VI-93	11-24-72	0910	005	25347	N	N	0.05K	0.53	0.06	3.0	N	N
VI-94	11-20-72	1155	000	25272	N	6.8	N	N	N	N	0	0
VI-94	11-22-72	1205	005	25344	N	6.7	N	N	N	N	2	23
VI-94	11-24-72	0855	005	25346	N	N	0.06	0.23	0.05K	5.0	N	N
VI-94A	11-22-72		005	25345	N	6.6	N	N	N	N	1	1
VI-95	11-20-72	1135	000	25271	N	6.6	N	N	N	N	0	0
VI-95	11-22-72	1150	005	25343	N	6.7	N	N	N	N	4	11
VI-96	11-20-72	1130	000	25270	N	7.0	N	N	N	N	0	0
VI-96	11-22-72	1145	005	25342	N	6.6	N	N	N	N	0	24
VI-97	11-20-72	1125	000	25269	N	6.4	N	N	N	N	0	0
VI-98	11-20-72	1122	000	25268	N	7.7	N	N	N	N	0	0
VI-99	11-20-72	1120	000	25267	N	6.8	N	N	N	N	0	0
VI-100	11-20-72	1100	000	25266	N	7.5	N	N	N	N	0	0
VI-100	11-22-72	1120	005	25338	N	6.6	N	N	N	N	32	76
VI-101	11-20-72	1052	000	25265	N	6.1	N	N	N	N	0	4
VI-101	11-22-72	1105	005	25337	N	6.3	N	N	N	N	0	2
VI-102	11-20-72	1038	000	25264	N	7.2	N	N	N	N	0	0
VI-102	11-22-72	1055	005	25336	N	6.6	N	N	N	N	4	94

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	WATER TEMP CENT 00010	DO MG/L 00300	NO3-N MG/L 00620	T KJL N MG/L 00625	PHS-T P-WET MG/L 00665	T ORG C MG/L 00680	COLIF MFFC 100ML 31616	COLIF MFTC 100ML 31501
VI-103	11-20-72	1030	000	25263	N	6.4	N	N	N	N	0	1
VI-103	11-22-72	1045	005	25335	N	6.4	0.05K	0.48	0.05K	23.0	0	2
VI-104	11-20-72	1001	000	25262	N	6.7	N	N	N	N	0	0
VI-104	11-22-72	1020	005	25334	N	6.6	N	N	N	N	15	46
VI-105	11-20-72	0928	000	25261	N	6.4	N	N	N	N	0	0
VI-105	11-22-72	1013	005	25333	N	6.3	N	N	N	N	0	240
VI-106	11-20-72	0926	000	25260	N	7.0	N	N	N	N	0	0
VI-106	11-22-72	1007	005	25332	N	6.3	N	N	N	N	120B	160B
VI-107A	11-22-72	0000	000	25282	N	N	N	N	N	N	0	0
VI-107A	11-22-72		000	25330	N	N	N	N	N	N	0	0
VI-107A	11-27-72		005	25377	N	N	0.05K	0.19	0.05	N	N	N
VI-107B	11-22-72	0000	000	25283	N	N	N	N	N	N	1	3
VI-107B	11-22-72		000	25331	N	N	N	N	N	N	1	2
VI-107B	11-27-72		005	25378	N	N	0.05K	0.38	0.06	N	N	N
VI-108	11-20-72	0921	000	25259	N	6.1	N	N	N	N	0	0
VI-108	11-22-72	0945	005	25329	N	6.0	N	N	N	N	26	240
VI-109	11-20-72	0925	000	25258	N	6.4	N	N	N	N	0	0
VI-109	11-22-72	0943	005	25328	N	6.1	N	N	N	N	120B	160B
VI-110	11-20-72	0920	000	25257	N	7.0	N	N	N	N	0	0
VI-110	11-21-72	1420	000	25318	N	7.1	N	N	N	N	0	0
VI-111	11-20-72	0915	000	25256	N	6.4	N	N	N	N	0	1
VI-111	11-21-72	1435	000	25319	N	6.3	N	N	N	N	0	0
VI-111	11-22-72	0933	005	25326	N	6.4	N	N	N	N	0	9
VI-112	11-22-72	0920	005	25389	N	6.2	N	N	N	N	1	12
VI-113	11-20-72	0855	000	25255	N	6.9	N	N	N	N	2	47
VI-113	11-21-72	1400	000	25316	N	6.1	N	N	N	N	0	0
VI-113	11-22-72	0930	005	25324	N	6.1	N	N	N	N	37	56
VI-114	11-20-72	0900	000	25254	N	6.5	N	N	N	N	0	0
VI-114	11-21-72	1410	000	25317	N	6.4	N	N	N	N	0	0
VI-114	11-22-72	0928	005	25325	N	6.1	N	N	N	N	0	58
VI-115	11-20-72	0850	000	25253	N	6.5	N	N	N	N	3	13
VI-115	11-21-72	1350	000	25315	N	6.6	N	N	N	N	0	0
VI-115	11-22-72	0918	005	25388	N	5.6	N	N	N	N	280	800B
VI-116	11-20-72	0845	000	25252	N	6.8	N	N	N	N	1	1
VI-116	11-21-72	1345	000	25314	N	7.4	N	N	N	N	0	0
VI-116	11-22-72	0903	005	25322	N	5.8	0.05K	0.28	0.05K	26.0	2	13
VI-117	11-21-72	1235	000	25312	N	N	N	N	N	N	270	1500
VI-117	11-24-72		005	25373	N	N	N	N	N	N	12	560
VI-118	11-20-72	0840	000	25251	N	6.7	N	N	N	N	650	1300
VI-118	11-21-72	1340	000	25313	N	6.5	N	N	N	N	0	0
VI-118	11-22-72	0850	005	25320	N	4.9	N	N	N	N	11	600
VI-119	11-20-72	0830	000	25250	N	6.4	N	N	N	N	0	0
VI-119	11-22-72	0856	005	25387	N	4.7	N	N	N	N	26	32
VI-120	11-21-72	1221	000	25311	N	N	N	N	N	N	0	0
VI-120	11-24-72		005	25372	N	N	N	N	N	N	0	72
VI-121	11-21-72	1220	000	25310	N	N	N	N	N	N	0	0
VI-121	11-24-72		005	25371	N	N	N	N	N	N	0	28
VI-122	11-21-72	1215	000	25309	N	N	N	N	N	N	0	0
VI-122	11-24-72		005	25370	N	N	N	N	N	N	4	21
VI-123	11-21-72	1205	000	25308	N	7.1	N	N	N	N	0	0
VI-123	11-24-72		005	25369	N	N	N	N	N	N	0	180

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	WATER TEMP CENT 00010	DO MG/L 00300	NO3-N MG/L 00620	T KJL N MG/L 00625	PHS-T P-WET MG/L 00665	T ORG C MG/L 00680	COLIF MFFC 100ML 31616	COLIF MFTC 100ML 31501
VI-124	11-21-72	1155	000	25307	N	6.7	N	N	N	N	0	0
VI-124	11-24-72	1230	005	25368	N	N	N	N	N	N	4	120
VI-125	11-21-72	1145	000	25306	N	N	0.05K	0.13	0.05K	27.0	0	0
VI-125	11-24-72	1215	005	25367	N	N	N	N	N	N	9	460
VI-126	11-21-72	1115	000	25305	N	6.9	N	N	N	N	1	1
VI-126	11-24-72	1200	005	25366	N	N	N	N	N	N	0	26
VI-128	11-27-72		005	25379	N	N	0.05K	0.13	0.05K	N	N	N

REMARKS-

B=COLONY COUNT OUTSIDE ACCEPTABLE RANGE, C=CALCULATED VALUE, J=ESTIMATED VALUE, K=LESS THAN, L=GREATER THAN, M=NEGATIVE VALUE, N=NO DATA AVAILABLE

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	CD TOTAL UG/L 01027	CR TOTAL UG/L 01034	PB TOTAL UG/L 01051	ZN TOTAL UG/L 01092	AL TOTAL UG/L 01105	CU TOTAL UG/L 01042	HG TOTAL UG/L 71900
VI-1	11-03-72		005	25829	47	10K	100K	410	200	30	0.25K
VI-1	11-16-72	1245	000	25194	130	30K	70K	130	200K	20	0.60
VI-3	11-03-72		005	25828	53	10K	100K	240	300	30	0.25K
VI-3	11-16-72	1228	000	25192	130	30K	70	250	200	15	1.60
VI-7	11-16-72	1445	000	25201	80	30K	70	210	200K	11	0.70
VI-10	11-16-72	1430	000	25198	80	30K	70	180	250	15	0.20K
VI-12	11-16-72	1412	000	25196	90	30K	70K	190	250	7	0.60
VI-16	11-17-72	1416	000	25223	30	30K	70K	340	400	11	0.20K
VI-19	11-17-72	1348	000	25220	30	30K	70K	170	430	11	0.20K
VI-21	11-17-72	1332	000	25218	70	30K	70	150	330	11	0.20K
VI-27	11-17-72	1203	000	25212	60	30K	70K	850	400	11	0.20
VI-31	11-17-72	1120	000	25208	60	30K	70	140	370	18	0.20
VI-34	11-17-72	1043	000	25206	60	30K	70K	370	370	15	0.20
VI-39	11-16-72	1013	000	25177	50	30K	70	240	200K	22	0.90
VI-40	11-16-72	1018	000	25178	70	30K	80	220	200K	29	0.60
VI-41	11-16-72	1032	000	25179	130	30K	80	180	200K	15	0.60
VI-43	11-16-72	1042	000	25181	110	30K	70	610	200K	26	0.70
VI-45	11-16-72	1055	000	25183	90	30K	70	190	200K	18	0.70
VI-51	11-18-72	0852	000	25229	40	30K	70K	460	520	11	0.20K
VI-53	11-18-72	0840	000	25226	30	30K	70K	80	320	11	0.20K
VI-55	11-18-72		000	25249	60	30K	70K	400	320	11	0.20K
VI-59	11-18-72	1236	000	25248	30	30K	70K	400	520	15	0.20K
VI-62	11-18-72	1225	000	25246	30	30K	70K	380	250	11	0.20K
VI-67	11-18-72		000	25240	30	30K	70K	320	400	7	0.20K
VI-69	11-18-72	1012	000	25238	40	30K	70K	150	320	11	0.20K
VI-70	11-18-72	1117	000	25243	30	30K	70K	350	430	11	0.20K
VI-71	11-18-72	0901	000	25230	40	30K	70	120	370	15	0.20K
VI-72B	11-18-72	0927	000	25233	30	30K	70K	240	400	11	0.20K
VI-72C	11-18-72	0938	000	25234	30	30K	70K	280	320	7	0.20K
VI-76	11-21-72	1058	000	25302	60	30K	70K	140	520	15	0.20
VI-76	11-24-72	1133	005	25363	30	30K	70K	80	430	80	0.20K
VI-77	11-24-72	1130	005	25362	40	30K	70K	90	430	80	0.20K
VI-86	11-21-72	0955	000	25293	30	30K	70K	80	320	52	0.20K
VI-87	11-21-72	0947	000	25292	40	30K	70K	80	320	20	0.20K
VI-87	11-24-72	1005	005	25353	30	30K	70K	150	590	112	0.50
VI-93	11-24-72	0910	005	25347	40	30K	70K	140	320	52	0.50
VI-94	11-24-72	0855	005	25346	50	30K	330	240	430	226	0.60
VI-103	11-22-72	1045	005	25335	30	30K	70K	110	370	45	0.20K
VI-107A	11-27-72		005	25377	20K	10K	100K	120	150	20	0.20K
VI-107B	11-27-72		005	25378	30	10K	100K	430	300	20	0.20K
VI-116	11-22-72	0903	005	25322	50	30K	70K	110	320	22	0.20K
VI-125	11-21-72	1145	000	25306	40	30K	80	70	560	11	0.40
VI-128	11-27-72		005	25379	20K	10K	100K	420	300	20	0.20K
VI-129G	11-03-72		005	25826	59	10K	100K	220	240	26	0.25K
VI-130G	11-03-72		005	25827	53	10K	100K	210	240	26	0.25K
VI-131G	11-03-72		005	25830	53	10K	100K	480	280	34	0.25K
VI-132G	11-03-72	1200	005	25831	35	12	100K	220	240	34	0.25K
VI-133G	11-03-72	1200	005	25832	53	11	100K	410	280	28	0.25K
VI-134G	11-03-72	1200	005	25833	35	11	100K	210	260	23	0.25K

REMARKS-
B=COLONY COUNT OUTSIDE ACCEPTABLE RANGE, C=CALCULATED VALUE, J=ESTIMATED VALUE, K=LESS THAN, L=GREATER THAN,
M=NEGATIVE VALUE, N=NO DATA AVAILABLE

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	FE SED. MG/KG 01170	MN SED. MG/KG 01053	SR SED. MG/KG 01083
VI-10	11-16-72	1431		25198	N	N	N
VI-13	11-21-72	1137		25384	N	N	N
VI-21A	11-21-72			25380	N	N	N
VI-21B	11-21-72			25381	N	N	N
VI-21C	11-21-72			25382	N	N	N
VI-21D	11-21-72			25383	N	N	N
VI-34	11-17-72	1044		25206	N	N	N
VI-86	11-24-72	1012		25354	N	N	N
VI-91	11-24-72	0940		25349	N	N	N
VI-92	11-24-72	0915		25348	N	N	N
VI-102	11-22-72	1056		25336	N	N	N
VI-107A	11-27-72			25385	N	N	N
VI-107B	11-27-72			25386	N	N	N
VI-116	11-22-72	0904		25322	N	N	N
VI-131G	11-03-72	1200		25834	16800	800	2300
VI-132G	11-03-72	1201		25835	2040	125K	4250
VI-133G	11-03-72	1201		25836	770	125K	4000
VI-134G	11-03-72	1201		25837	142	125K	2900

REMARKS-
B=COLONY COUNT OUTSIDE ACCEPTABLE RANGE, C=CALCULATED VALUE, J=ESTIMATED VALUE, K=LESS THAN, L=GREATER THAN,
M=NEGATIVE VALUE, N=NO DATA AVAILABLE

APPENDIX E SURVEY OF THE U.S. VIRGIN ISLANDS - NOVEMBER 3 TO 27, 1972

STATION	DATE	TIME	DEPTH FT	LAB NO. 00008	SED MOIST -URE 70320	CD SED. MG/KG 01028	CR SED. MG/KG 01029	PB SED. MG/KG 01052	ZN SED. MG/KG 01093	AL SED. MG/KG 01108	CU SED. MG/KG 01043	HG SED. MG/KG 71920
VI-10	11-16-72	1431		25198	59.1	9.8	31.7	352	540.00	N	103.0	0.150
VI-13	11-21-72	1137		25384	N	13.0	6.0	31	7.20	N	7.9	0.006
VI-21A	11-21-72			25380	23.4	11.2	5.1	35	8.80	N	8.2	0.009
VI-21B	11-21-72			25381	31.7	12.3	5.6	35	8.10	N	7.2	0.007
VI-21C	11-21-72			25382	25.7	12.5	6.3	36	8.20	N	7.3	0.008
VI-21D	11-21-72			25383	28.7	10.5	6.6	41	10.80	N	9.4	0.011
VI-34	11-17-72	1044		25206	60.4	3.8	18.4	61	94.00	N	53.0	0.063
VI-86	11-24-72	1012		25354	37.4	9.8	7.9	45	26.00	N	16.0	0.025
VI-91	11-24-72	0940		25349	47.6	7.6	26.5	50	34.00	N	40.0	0.014
VI-92	11-24-72	0915		25348	42.0	10.2	12.0	54	35.00	N	17.0	0.009
VI-102	11-22-72	1056		25336	26.7	14.2	9.2	37	11.50	N	7.3	0.008
VI-107A	11-27-72			25385	24.3	2.5	7.0	32	5.00	N	9.0	0.006
VI-107B	11-27-72			25386	18.6	3.8	8.3	33	5.20	N	6.3	0.007
VI-116	11-22-72	0904		25322	26.3	13.0	10.2	38	10.40	N	8.9	0.012
VI-131G	11-03-72	1200		25834	63.3	12.6	19.0	180	200.00	12000.0	84.0	2.400
VI-132G	11-03-72	1201		25835	71.7	9.2	8.8	71	13.90	1360.0	13.9	0.320
VI-133G	11-03-72	1201		25836	72.8	5.1	1.5	19	1.32	8.4	3.3	0.077
VI-134G	11-03-72	1201		25837	69.6	56.0	9.2	63	60.00	6300.0	30.0	0.046

REMARKS-
B=COLONY COUNT OUTSIDE ACCEPTABLE RANGE, C=CALCULATED VALUE, J=ESTIMATED VALUE, K=LESS THAN, L=GREATER THAN,
M=NEGATIVE VALUE, N=NO DATA AVAILABLE

APPENDIX F

BACTERIOLOGICAL ASSAYS

Coliforms

Water samples collected for bacteriological examination were held at ambient temperature during transit. The time lag between sample collection and initiation of analysis averaged six hours. Normal practices for sample storage include holding at refrigeration temperatures (2-10^{o}C). However, in order to eliminate possible thermal shock and subsequent cell mortality, the samples were transported under ambient conditions which approximated the temperature of the water samples. Water temperature during the study period averaged 28.3^{o}C (82.9^{o}F).

The Membrane Filter (MF) technique was used to assay total and fecal coliform bacteria. m-Endo-MF and m-FC media were used to enumerate total and fecal coliforms respectively. Coliform and fecal coliform colonies from selected stations were subjected to biochemical testing for verification. These included stations at Charlotte Amalie Harbor (St. Thomas), Honeymoon Bay (St. Thomas), Christiansted Harbor (St. Croix), Frederiksted (St. Croix), Prune Bay (St. Croix), and Cruz Bay (St. John). Total coliform colonies appearing on m-Endo medium exhibited the characteristic metallic sheen. Eighty-seven percent of such colonies tested, confirmed biochemically as coliform bacteria. Red, non-metallic sheen colonies did not confirm as coliform group organisms. Fecal coliform colonies on m-FC medium appeared as blue colonies with many containing crystal or granular surfaces and edges. Eighty-three percent of the blue colored colonies tested (including those with tan or brown centers) gave biochemical reactions typical of fecal coliform bacteria. A number of non-blue colonies were analyzed and these failed to provide typical biochemical reactions for fecal coliforms. The confirmations substantiate the fact that typical total coliforms and fecal coliforms, as indicated by normal reactions on the respective media, were being assayed.

High densities of background organisms were encountered at sampling stations in Christiansted Harbor, St. Croix and Charlotte Amalie, St. Thomas. Predominant organisms proliferating on m-FC medium and producing brownish colored colonies ranged in size from 0.5 mm to 1.5 mm. Dominant characteristics noted on the m-FC membranes were: foaming produced at the peripheral portions of the membrane, production of a slime layer and presence of a fruity odor. Biochemically, the organisms were identified as *Pseudomonas aeruginosa*. Since these colonies were present in large numbers on m-FC membranes, 'crowding' effect and inhibition of fecal coliforms was evident. The degree of inhibition occurring on the membrane is not known; however, considerable background still remained even at higher sample dilutions. It was not possible to dilute out these organisms without falling out of the effective statistical fecal coliform density range. Several of the stations at St. Thomas exhibited similar background growth; however, fecal coliform colonies were absent on the membranes. The complete absence of fecal coliforms on the membranes and the presence of P. aeruginosa poses an intriguing situation—especially since P. aeruginosa is a recognized human pathogen and is associated with sewage and polluted water. In addition, several grayish, translucent colonies, 0.5 mm - 1.0 mm in size, were found on the membranes. These organisms were identified as Alcaligenes faecalis. The microorganisms are widely distributed in decomposing organic matter and are found in the intestine.

The above information indicates that die-off rates of fecal coliform in these waters may be extremely rapid. Or, interference and sensitivity levels of the MF fecal coliform test prevents adequate recovery at low density levels. Further study is therefore required to determine the following:

(A) Survival rates of fecal coliforms, P. aeruginosa and Salmonella in Virgin Islands waters, especially at Charlotte Amalie Harbor, St. Thomas and Christiansted Harbor, St. Croix.

(B) The degree of inhibition or interference by Pseudomonas organisms on the recovery of fecal coliforms by the MF technique.

(C) The sensitivity levels required to detect low fecal coliform levels in these waters.

Salmonella

Two liters of sample water were filtered using diatomaceous earth (Celite, Johns-Manville Co.). After filtration of the sample, the Celite plug containing the trapped microorganisms was placed in Selenite Cystine Broth. The above is repeated; however, the second Celite plug is placed in Tetrathionate Broth containing Brilliant Green Dye. After incubation of the enrichment broths for 24 hours at 37°C, primary isolation media, (Brilliant Green Agar, Xylose Lysine Brilliant Green Agar) were streaked with inocula obtained from the enrichment broths. (This process was repeated at 48-hours and 72-hours incubation of the enrichment broths.) Typical Salmonella colonies were picked and agar slants of the pure culture were prepared. After 24 hours incubation at 37°C, the agar slants were shipped via air to the Edison, N.J. laboratory for identification. Upon arrival at the Edison laboratory, the cultures were transferred into fresh media and checked for purity. A Salmonella Fluorescent Antibody

(FA) technique was used to screen the cultures. Difco Panvalent conjugate, which includes strains of Salmonella and Arizona cultures representing all known somatic and flagellar antigens in the genus Salmonella was used. FA negative cultures were discarded. FA positive cultures were then characterized biochemically. Serological tests were then used to determine Group and serotype identification.

Two liters of sample water were collected from stations 4, 8, 9, 10, 11 and 13 at Charlotte Amalie, St. Thomas. Salmonellae were not detected at stations 4, 8, 10, 11 and 13. Salmonella enteritidis ser. senftenberg was isolated from station 9, which is adjacent to the municipal dump area at Charlotte Amalie.

APPENDIX G

DETERMINATION OF METALS IN SEAWATER

Large amounts of sodium interfere with the detection and quantification of metals in seawater. In order to remove this interference, a cleanup method based on a procedure described by O. Karmie Galle[1] was employed for the seawater samples. Basically, the cleanup is accomplished through the use of ion exchange columns.

I. Preparation of the Ion Exchange Columns:

(A) Pack 25 ml burrettes containing a wad of cotton with an aqueous slurry of Dowex A-1 chelating resin[2] to obtain ultimate resin heights of 12.5 cm in each column. Incorporate one (1) ml of a methyl orange solution, containing 0.125 g of the dye per liter of water in the slurry.

(B) Add 25 ml of 30% ammonium hydroxide through each column, and drain to about 1 cm above the top of the resin bed.

(C) Wash distilled, deionized water through each column until the eluate no longer turns red litmus paper to a blue color.

(D) Add 20% ammonium chloride solution, containing 0.0125% aqueous methyl orange solution, through each column until eluate reaches pH 6-8. Generally 30-50 ml of the solution is required for each column.

II. Sample Cleanup:

(A) Sample should have been preserved with 5 ml/l lead-free nitric acid. Consequently, 100.0 ml of each sample is treated with several drops of 0.0125% aqueous methyl orange solution, and 50% sodium hydroxide solution is added dropwise with stirring until the pH reaches 6-8, as indicated by a pH meter.

(B) Each sample is added to an ion exchange column, as prepared above, and is allowed to drain at a rate of 3.0 ml/min.

(C) When each solution has drained to within 1 cm above the resin beds, 30 ml of 10% ammonium chloride are added and passed through the column at a rate of 3.0 ml/min. All of these eluates are discarded.

(D) When each solution has drained to within 1 cm of the top of the resin bed, 30 ml of 1 N hydrochloric acid solution is added to each column.

(E) The progress of the elution of the acid front is followed by the color change of the methyl orange. When the acid front has reached to about 1 inch above the bottoms of the resin beds, 100 ml volumetric flasks are placed under each column to collect the eluates.

(F) When the acid solutions have drained to within 1 cm of the tops of the resin beds, 15 ml of 0.05 N hydrochloric acid solution is added to each column and allowed to drain, as above, into the volumetric flasks.

(G) Distilled, deionized water is then added to each column and allowed to drain into the volumetric flasks until 100.0 ml of eluate are collected.

III. Atomic Absorption Determination of Metals:

The metallic contents of the solutions were determined on a Perkin Elmer 403 atomic absorption spectrophotometer using the manufacturer's prescribed methodology by direct aspiration.

IV. Reference and Notes:

1. Galle, O. Karmie, "The Determination of Trace Elements By Atomic Absorption", J. Appl. Spec., Vol. 25, No. 6, 664-669 (1971).

2. May be obtained from J. T. Baker Chemical Co., Phillipsburg, N.J.

3. In this method, sodium elutes prior to the addition of the hydrochloric acid solutions, which then elute the other metals.

APPENDIX H

DETERMINATION OF METALS IN SEDIMENTS

1. Preweigh beaker.

2. Dry about 30-35 g of sample in a 400 ml beaker on steam bath.

3. Reweigh, and calculate % solids.

4. Add 20 ml of conc. nitric acid and 1 ml of hydrogen peroxide and evaporate to dryness.

5. Ash in muffle furnace at 400-425°C for 1 hour.

6. Let cool and add 25 ml of mixed acid.*

7. Heat on steam bath for 15 minutes and let cool.

8. Filter. Wash filter several times with distilled water. Dilute filtrate to 200 ml in a volumetric flask.

9. Determine each metal by atomic absorption spectroscopy by direct aspiration.

10. Report data on a dry weight basis.

*Mixed acid: 200 ml conc. nitric acid.
50 ml conc. hydrochloric acid.
750 ml distilled water
4.72 g $Ca\ (NO_3)_2 \cdot 4\ H_2O$.
80 g NH_4Cl.