APPRAISAL OF THE UNEP METHODS FOR DETERMINING POLLUTANTS IN COASTAL WATERS FOR USE IN THE PACIFIC ISLANDS.

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INTRODUCTION

As part of the 1983 South Pacific Regional Environment Programme (SPREP) workplan for the Coastal and Inland Water Project the Institute of Natural Resources initiated a laboratory based project to test the applicability of the United Nations Environment Programme (UNEP) Standard Methods for use in laboratories of the SPREP region. A range of UNEP Standard Methods (as supplied by Dr S. Keckes) was tested in the INR laboratory to determine the range of applicability, the level of expertise needed, the equipment requirements and the cost of carrying out the analyses.

REPORT

In the second half of 1982 the UNEP Regional Seas Programme began publishing a series of methods for determining pollutants in the marine environment. At present 11 of the 20 proposed methods have been received, the other 9 being still in preparation. The 11 received are:

No. 1 Guidelines for Monitoring the Quality of Coastal Recreational and Shellfish Growing Waters

No. 2 Determination of Total Coliforms in Sea-Water by the Membrane Filtration Culture Method

No. 3 Determination of Faecal Coliforms in Sea-Water by the Membrane Filtration Culture Method

No. 4 Determination of Faecal Streptococci in Sea-Water by the Membrane Filtration Culture Method

No. 5 Determination of Faecal Coliforms in Bivalves by the Multiple Test Tube Method

No. 7 Sampling of Selected Marine Organisms and Sample Preparation for Trace Metal Analysis

No. 8 Determination of Total Mercury in Selected Marine Organisms by Flameless Atomic Absorption Spectrophotometry

No. 11 Determination of Total Cadmium, Zinc, Lead and Copper in Selected Marine Organisms by Atomic Absorption Spectrophotometry

No. 12 Sampling of Selected Marine Organisms and Sample Preparation for the Analysis of Chlorinated Hydrocarbons

No. 14 Determination of DDTs and PCBs in Selected Marine Organisms by Gas-Liquid Chromatography

No. 16 Determination of FFTs, PCBs, PCCs and other Hydrocarbons in Sea-Water by Gas Chromatography

No. 17 Determination of DDTs, PCBs, PCCs and other Hydrocarbons in Marine Sediments by Gas-Liquid Chromatography

As proposed, in the Coastal and Inland Water Quality Project for 1983 a number of these methods were laboratory tested in INR over the period September-December. In the time available only a selection of the methods could be attempted and the selection was based on available equipment and immediate relevance to Pacific island needs. As INR's Gas Chromatograph did not arrive till January, 1984, methods 12-17 were excluded. The pressure teflon vessels needed for sample digestion in methods 8 and 11 were not available and so although some heavy metals were determined the results may not be exactly the same as if the recommended digestion had been used. Since shellfish are a major food item in most Pacific island states and the most likely pollution source at present is sewage, methods 1 to 5 are of particular interest.

An area of coastline on Laucala Bay close to the INR laboratory was chosen as a test site (see maps). In this area (1) extensive mudflats are exposed at low tide; (2) sites marked 2, 3, 7 and 8 are commonly used for swimming areas; (3) bivalves are intensively collected on the mudflats; (4) untreated sewage enters the sea through stream 1.

Water was collected at high tide from eight sampling sites on a number of occasions (see results) and analyses performed for total coliforms, faecal coliforms and faecal streptococci. The two main species of bivalve eaten from this area (Anadara antiquata and Gafrarium tumidum) were collected on a number of occasions from the area marked on Map 2 and analysed for faecal coliforms and heavy metals. In addition a major food item - the freshwater bivalve (Batissa violaces) was purchased from the Suva market and analysed for faecal coliforms and heavy metals. These bivalves come from

Fiji's largest river - the Rewa - about 25 km from Suva (Figure 1) part of which flows into Laucala Bay.

COMMENTS ON METHODS

The methods were tested in the INR laboratory which is well equipped with basic chemical equipment and has a substantial chemical and glassware store. The laboratory employs three professional analytical chemists with a combined total of 40 years experience and five experienced technicians. The technician who performed the tests on the methods has partially completed the New Zealand University Entrance examination, has completed a one year technician training course at the Fiji Institute of Technology and has worked as an analyst for one year in the INR in the field of water and soil analysis. This should be borne in mind when evaluating the comments made on difficulties encountered in trialling the methods.

No. 1
- o Only the minimum monitoring scheme would be feasible at this stage in island countries.
- o None of the required subsidiary information should be difficult to obtain for an extended monitoring programme.

No. 2&3
- o No problems were encountered with either of these methods. Pre-sterilized MFs were used, with commercial ready-to-use broth ampules. A replication test on the faecal coliform method gave the results shown in Table 1.

No. 4
- o No results are shown for faecal streptococci as the agar base used had deteriorated and would not gel properly.

No. 5
- o No problems were encountered with this method. Methods 1-5 could all be carried out in any major hospital laboratory in the region and are thus suitable for all regional countries excluding possibly Tokelau, Wallis and Futuna and Norfolk Island.

No. 7
- o This method was only tested for bivalves but no difficulties were foreseen if shrimp or fish were to be sampled.

No. 8
- o As teflon digestion vessels were not available an alternative digestion method using nitric acid and hydrogen peroxide was used (Ref. 1).
- o Relatively high reagent blanks were noticed but since the pressure digestion method uses less quantity and a lesser number of reagents this should alleviate the problem.

No. 11
- o The digestion was performed as in Ref. 1.
- o No problems were encountered with this method but hopefully in the future through intercalibration exercises and the use of standard samples the reliability of the determinations can be improved.

Methods 7-17 could only be carried out successfully in laboratories fully equipped for such work staffed with highly trained, experienced analysts. We suggest these methods be confined to such laboratories e.g. WERI and GEPA on Guam, UNPG Environmental Laboratories and the National Analysis Laboratory in PNG, INR in Fiji and suitable laboratories in New Caledonia and LESE in French Polynesia.

COSTING

A. For bacteriological work in water and shellfish (i.e. Methods 2-5) the following equipment is required with approximate costings in $US.

General laboratory items	$1,500
Membrane Filtration Apparatus	500
Plate incubator	800
2 Water incubators, 2 x 400	800
Microscope	700
Autoclave	2,000
Balance	1,500
Homogenizer + vessels	250
Water Deionizer system	200
Refrigerator	1,000
TOTAL	$9,200

For water analysis using commercial pre-prepared sterile membrane filter, culture medium ampule and disposable petri dish the cost is $1.70 per determination. Each dilution also costs $1.70.

B. For heavy metal work in marine organisms (Methods 8 & 11) the following equipment is required with approximate costings in $US.

Teflon digestion vessels 6 x 200	1,200
Hot plate	400
Micropipettes 2 x 100	200
Homogenizer + vessels	250
Analytical balance	2,400
Atomic Absorption Spectrophotometer (AAS)	14,000
AAS lamps for Hg, Cd, Zn, Pb, Cu	600
Graphite Furnace Atomizer for AAS (desirable option)	10,000
Mercury aeration flask	500
Mercury measuring cell	200
I.R. Heater	100
Dessicator	100
Drying oven	700
Freeze-dryer	2,500
Laminar flow hood	800
General laboratory equipment	4,000
TOTAL	$37,950

A laboratory with fume hoods, water and gas on tap, compressed air and acetylene available etc. is of course also required.

TABLE I - Replication Exercise on the Faecal Coliform Method

Dilution	Replicate 1	2	3
100 ml	TNC*	TNC	TNC
10 ml	115	84	80
1 ml	16	9	12
0.1 ml	2	0	2
0.01 ml	0	1	0

*TNC - Too numerous to count

Mean 930, Range 800-1150, S.D. 190

TABLE 2 - Total Coliforms in Water

Site No.	Organisms/100 ml	
Date of Sampling	4/10	12/10
1	32000	30
2	6000	5
3	5600	<1
4	4700	6000
5	6700	200
6	440	1600
7	NS	4100
8	NS	260

N.S.: not sampled

TABLE 3 - Faecal Coliforms in Water

Site No. / Date of Sampling	Organisms/100 ml 4/10	12/10	30/11	20/12
1	750	16	260	590
2	14	<1	140	1020
3	24	<1	2300	150
4	140	930	600	1200
5	40	1	80	240
6	4	57	28	70
7	NS	2700	100	180
8	NS	9	22	930

N.S.: not sampled

TABLE 4 - Faecal Coliforms in Bivalves

A. Batissa violaces

25/10 >2,400 Fc/gn

15/12 21,000 Fc/gn

B. Gafrarium tumidum

(Size range 4.0 - 5.5 cm, mean 4.5 cm; mean mass (wet weight) 2.9g)

18/12 1,100 Fc/gn

C. Anadara antiquata

(Size range 4.3 - 5.8 cm, mean 4.8 cm; mean mass (wet weight) 5.2g)

18/12 280 Fc/gn

TABLE 5 - Heavy Metals in Bivalves

Metal	Sample 1* (mg/kg)	Sample 2* (mg/kg)	Sample 3* (mg/kg)
Hg	N.D.	0.15	0.19
Cu	8.0	9.8	9.8
Zn	7.2	21	22
Pb	11	6.0	15
Cd	0.26	0.60	1.1

N.D.: Not done

* Sample 1 - 10 mixed Anadara and Gafrarium 2.5 cm - 4.5 cm in length

Sample 2 - 13 small Batissa, 4.3 - 5.2 cm, mean 5.0; 1.8 - 5.2g, mean 3.4g

Sample 3 - 13 larger Batissa, 5.2 - 6.5 cm, mean 5.6 cm; 4.7 - 7.0g, mean 5.7g

REFERENCES

1. Egan, H., Kirk, R.S. and Sawyer, R. Pearson's Chemical Analysis of Food. 8th Ed., Churchill Livingston, 1981.

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FIGURE 1

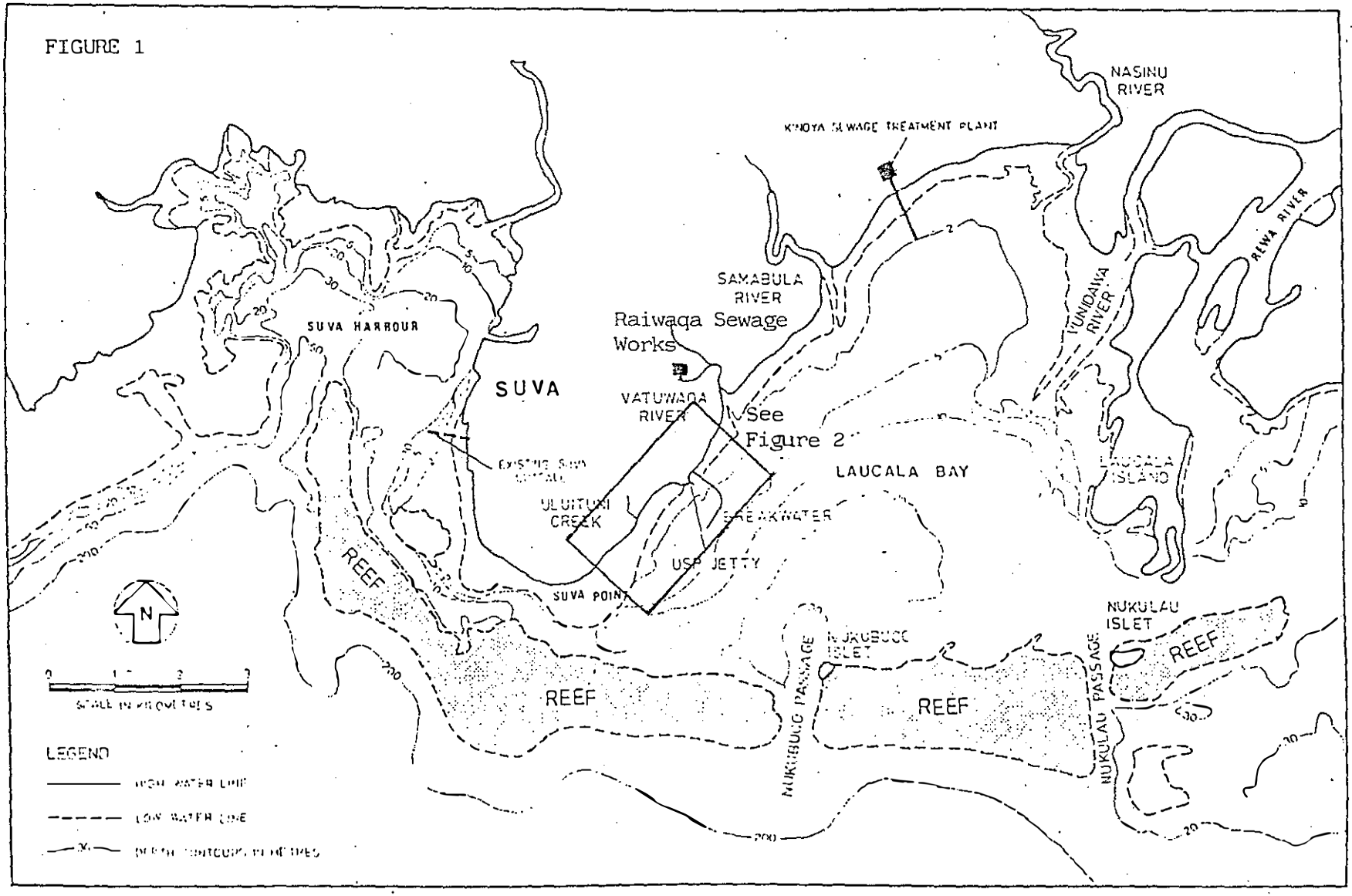
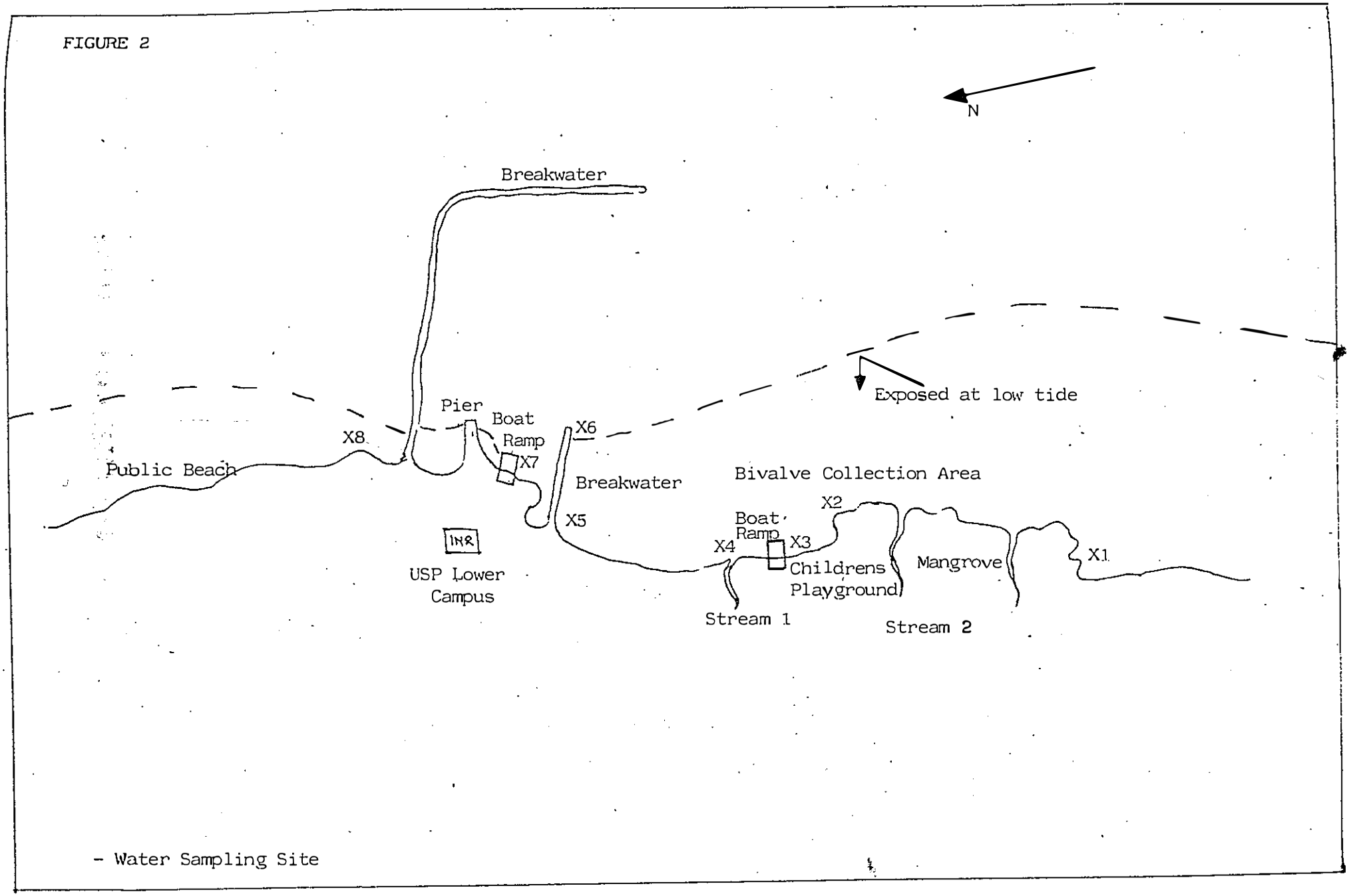

NASINU RIVER
KINOYA SEWAGE TREATMENT PLANT
SAMABULA RIVER
Raiwaqa Sewage Works
TUNIDAVA RIVER
REWA RIVER
SUVA HARBOUR
SUVA
VATUWAQA RIVER
See Figure 2
LAUCALA BAY
LAUCALA ISLAND
ULUITUNI CREEK
BREAKWATER
USP JETTY
SUVA POINT
REEF
NUKULAU ISLET
NUKUBUCO ISLET
NUKUBUCO PASSAGE
NUKULAU PASSAGE
N
SCALE IN KILOMETRES
LEGEND
HIGH WATER LINE
LOW WATER LINE
DEPTH CONTOURS IN METRES

FIGURE 2


N
Breakwater
Exposed at low tide
Pier
Boat
Ramp
X8
X7
X6
Public Beach
Breakwater
Bivalve Collection Area
X2
Boat
Ramp
X5
X4
X3
INR
USP Lower
Campus
Childrens
Playground
Mangrove
X1
Stream 1
Stream 2
- Water Sampling Site