WATER QUALITY IN THE MONASAVU RESERVOIR AND WAILOA RIVER IN 1989

INR TECHNICAL REPORT NO 90/2

April, 1990

INSTITUTE OF NATURAL RESOURCES
UNIVERSITY OF THE SOUTH PACIFIC

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Report prepared for the Fiji Electricity Authority

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INTRODUCTION

At the request of Fiji Electricity Authority (FEA), the Institute of Natural Resources monitored the water quality of Monasavu reservoir and the Wailoa river again in 1989. The programme was carried out in accordance with the proposal submitted to the FEA at the beginning of 1989 (Appendix 1).

THE MONITORING PROGRAMME

1) The Organisation

The monitoring of the Monasavu reservoir and the Wailoa river were carried out in July 1989 and February 1990 and the details of the parameters analyzed are shown in Table 1

TABLE 1

Monitoring Programme of Monasavu Reservoir and Wailoa River

	No of sites monitored	Monitoring sequence	Parameters measured
Monasavu reservoir	3 Stations each at 3 different depths	11-12/7/89 6-7/2/90	Temperature and dissolved oxygen profiles, pH, alkalinity, chlorophyll a, b and c, nutrients - total nitrogen, phosphorus and sulphur, ammonia, nitrate, nitrite, dissolved and total iron and manganese
Wailoa	3 Stations	12/7/89 6-7/2/90	As above except for invertebrate survey

2) Sampling Sites

The sites chosen for sampling in 1989 remained the same as for previous years (1984-1988) for comparison purpose. Figure 1 shows the location of the three sampling sites in the reservoir while Figure 2 shows the sampling stations along the Wailoa river. Station 4 is located at Laselevu village.

3) Results

Apart from temperature and dissolved oxygen which were determined on site, the rest of the analyses were carried out at the INR laboratory. Tables 2 and 3 summarise the results of the anlyses carried out on the samples.

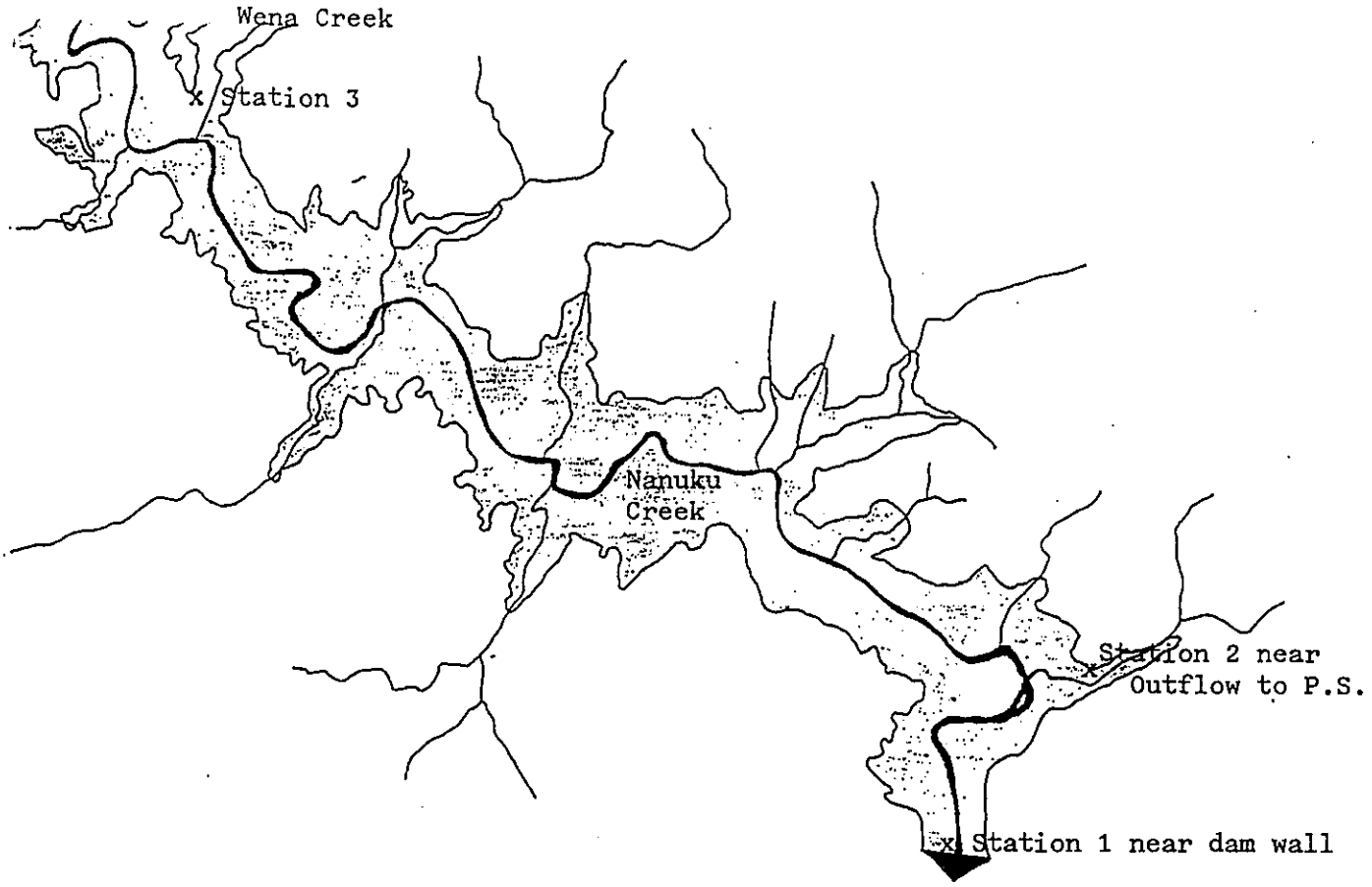

FIGURE 1 : Location of the sampling stations in the Monasavu Reservoir

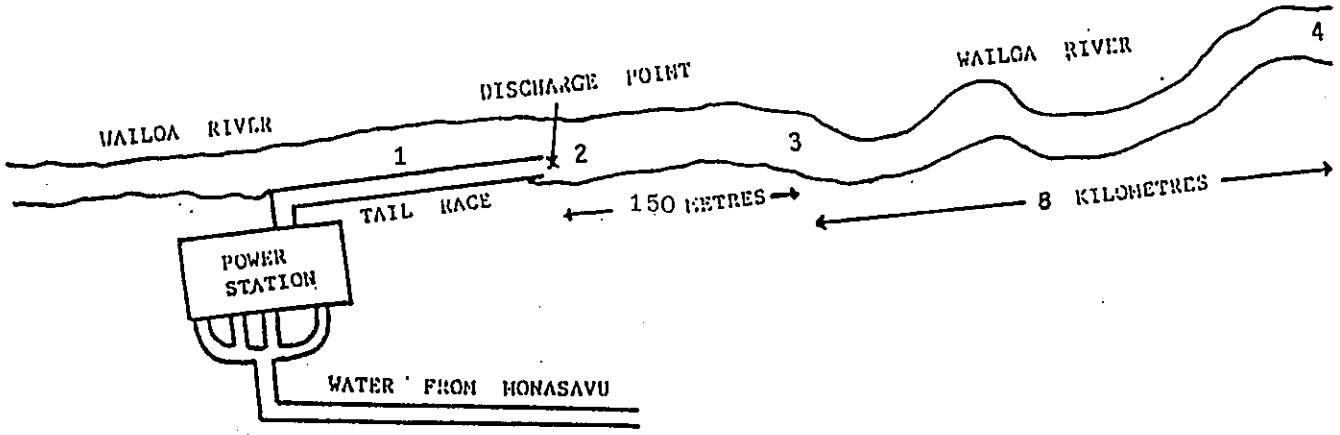

FIGURE 2 : Sampling sites along the Wailoa River

Site : 1 100 m above P.S. discharge
2 Tailrace
3 150 m below P.S. discharge
4 Wailoa at Laselevu

TABLE 2 : MONASAVU AND WAILOA WATER SAMPLES 11/12 July 1989

Parameter/Lab No.	Stn 1 Sur M89/878	Stn 1 Mid 879	Stn 1 Bot 880	Stn 2 Sur 881	Stn 2 Mid 882	Stn 2 Bot 883	Stn 3 Sur 884	Stn 3 Mid 885	Stn 3 Bot 886	Wailoa Above P.S 887	Wailoa Tailrace 888	Wailoa at Laselevu 889
Depth (m)	0	30	62	0	19	37	0	19	39	0	0	0
Clarity (m)	3			3			3					
Temperature (oC)	20.1	19.5	18.8	20.1	19.5	18.9	20.2	19.0	18.5	20.5	20.5	21.0
Dissolved O2 (mg/L)	8.2	6.8	3.0	8.4	7.5	6.9	8.8	7.3	6.9	8.5	8.6	8.5
pH (Lab)	6.9	6.5	6.4	6.7	6.5	6.2	6.4	6.5	6.4	7.8	6.6	7.5
Alkalinity (mg/L CaCO3)	14.0	15.5	38.5	6.5	15.0	16.0	15.5	17.0	16.0	22.5	15.5	24.5
Total N (mg/L)	0.9	1.2	2.5	0.5	0.5	1.0	1.3	1.7	0.8	1.6	1.3	1.8
NO3 (ug/L)	211	112	62	68	62	87	62	68	87	186	117	161
Total P (ug/L)	10	<6	268	15	14	23	10	14	19	41	39	34
Dissolved PO4 (ug/L)	<6	<6	65	<6	<6	8	<6	<6	<6	9	<6	<6
Total S (mg/L)	0.1	0.3	3.2	0.3	0.3	3.1	<0.1	<0.1	1.0	0.1	3.0	3.0
Total Fe (mg/L)	0.03	0.04	4.7	0.02	0.02	0.34	0.02	0.02	0.05	<0.01	0.20	0.07
Dissolved Fe (mg/L)	<0.01	<0.01	0.50	<0.01	<0.01	<0.01	0.10	<0.01	0.03	<0.01	0.06	<0.01
Total Mn (mg/L)	0.02	0.01	1.5	<0.01	0.01	0.01	0.02	<0.01	0.02	<0.01	0.05	0.02
Dissolved Mn (mg/L)	0.02	0.01	1.4	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.04	0.02
Chlorophyll a (mg/m3)	11	12	2	3	13	17	0	4	1	3	n.d.	1
b	20	33	4	11	16	35	0	5	0	35	n.d.	10
c	20	80	33	36	105	126	0	44	0	76	n.d.	10

n.d. = no data

TABLE 3 : MONASAVU AND WAILOA WATER SAMPLES 6/7 February 1990

	Stn 1 Sur	Stn 1 Mid	Stn 1 Bot	Stn 2 Sur	Stn 2 Mid	Stn 2 Bot	Stn 3 Sur	Stn 3 Mid	Stn 3 Bot	Wailoa Above P.S.	Wailoa Tailrace	Wailoa at Laselevu
Parameter/Lab. No M90/	154	155	156	157	158	159	160	161	162	163	164	165
Depth (m)	0	30	60	0	16	32	0	15	3	0	0	0
Clarity (m)	3			3			2.2					
Temperature (oC)	24.8	21.8	19.5	25.2	22.4	21.8	25.9	22.4	22.4	22.8	22.2	23.0
Dissolved O2 (mg/L)	7.6	0.5	0	7.2	2.0	0	7.2	0	0	7.3	7.5	7.9
pH (Lab)	9.0	7.7	6.0	9.0	6.9	6.6	9.2	7.8	6.9	7.4	6.4	6.7
Alkalinity (mg/L CaCO3)	18.9	17.9	33.7	17.4	16.9	16.4	20.4	17.4	18.4	46.3	16.9	26.5
Total N (mg/L)	0.6	0.3	2.1	1.4	0.9	0.7	0.8	0.4	0.6	0.5	0.5	0.6
NO3 (ug/L)	36	36	34	28	<10	11	<10	<10	<10	149	222	109
NH3 (ug/L)	20	16	930	20	12	12	20	12	68	12	62	20
Total P (ug/L)	93	59	119	93	136	68	59	110	59	85	93	76
Dissolved PO4 (ug/L)	<6	<6	15	8	9	11	10	10	11	<6	7	<6
Total S (mg/L)	<0.1	8.3	1.7	6.7	<0.1	1.7	<0.1	8.3	<0.1	5.0	3.3	11.7
Total Fe (mg/L)	<0.01	<0.01	0.80	<0.01	<0.01	<0.01	0.10	0.10	0.40	<0.01	0.10	<0.01
Dissolved Fe (mg/L)	<0.01	<0.01	0.50	<0.01	<0.01	<0.01	0.10	<0.01	0.40	<0.01	0.10	<0.01
Total Mn (mg/L)	<0.01	<0.01	0.72	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Dissolved Mn (mg/L)	<0.01	<0.01	0.71	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Chlorophyll a (mg/m3)	5	18	4	n.d.	0	11	11	11	1	13	7	0
b	4	26	0	n.d.	3	19	0	21	0	13	7	11
c	26	22	16	n.d.	23	86	54	59	34	24	67	102

n.d. = no data

4) Interpretation of Results

4.1 The Monasavu Reservoir

a) Temperature and Dissolved Oxygen profiles

Figure 3 shows the temperature and the dissolved oxygen profiles of the three reservoir stations obtained during the sampling visits. As in previous years (1984-1988), the lake is fairly homothermal during the winter period with significant levels of oxygen even at depths >60 m. In the summer, however, a marked change occurred with oxygen being absent at depth. The depth to zero dissolved oxygen varied from 8 m at station 3 to about 35 m at stations 1 and 2. At station 2 there was an irregular pattern of oxygen distribution with depth that may be related to water movements associated with the feeding of deeper water to the power station.

The overall pattern is similar to that reported previously (Brodie et al., 1987; Naidu and Brodie, 1987; Naidu, 1988) and is best explained by thermal stratification of the dam in the warmer months followed by depletion of the dissolved oxygen in the deeper water via decomposition of organic matter. There was still a smell of sulphide apparent at the power station contrary to information reported for 1988. The levels, however, were considerably lower than those of several years ago.

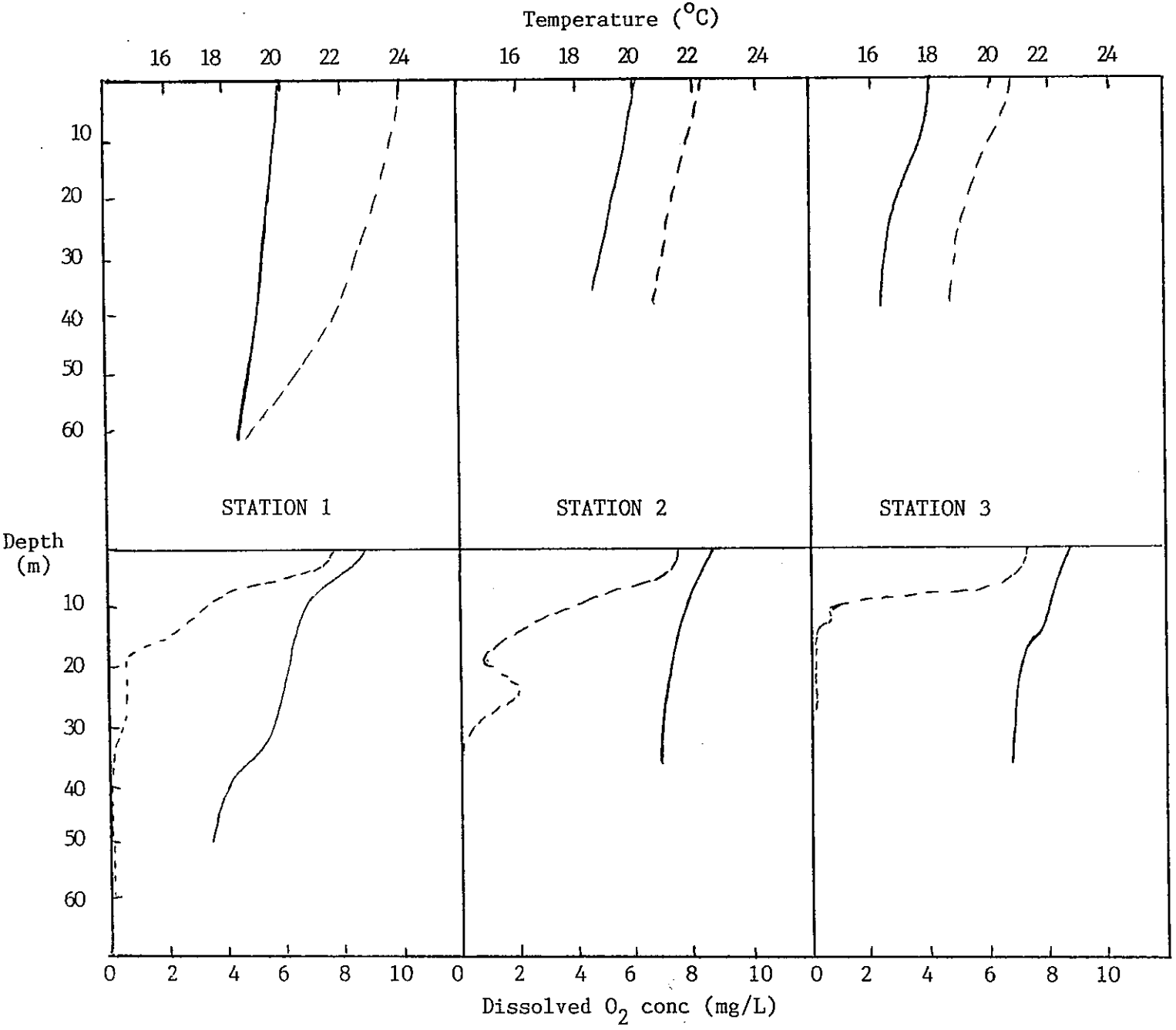

Figure 3 :

Temperature and Dissolved Oxygen Profiles for Monasavu Dam in July 1989 and February 1990

b) pH

The pH values range from 6.0 to 9.2. In the February sampling high values (9.0-9.2) were recorded for the surface samples at all 3 stations. The instrument response for these samples, however, was extremely sluggish (approximately 15 minutes to stabilize- normally <1 minute) possibly indicating that the glass electrode was being coated with some gelatinous substance which in turn produced the anomalously high readings.

Apart from these 3 readings the range was 6.0-7.8 much as observed previously; there was no significant pattern to the values obtained except that pH tended to decrease with depth as noted in previous reports.

c) Nutrients

i) Nitrogen

With only 2 samplings per year it is difficult to draw many conclusions about the behaviour of nitrogen and its different forms. Total nitrogen values ranged from 0.3-2.5 mg/L, similar to previous years with the values generally increasing with depth at stations 1 and 2, but showing no real pattern at station 3. For nitrate values ranged from 3-211 ug/L with no obvious pattern except the values in the summer were less than those in winter, possibly a consequence of greater photosynthetic utilization. For ammonia values ranged from 12-1445 ug/L with the concentrations increasing

with depth. This is to be expected as in surface waters, the oyxgen present limits the formation of ammonia, while at depth, lower levels of dissolved oxygen tend to favour ammonia production.

ii) Phosphorus

Total phosphorus values ranged from <6-268 ug/L, a similar range (Naidu et al., 1989) to 1988 (<6-234 ug/L). Values were generally greater in the February 1989 samples; no obvious explanation for this is apparent.

Dissolved phosphate (PO4) values were generally low ranging from <6-65 ug/L, somewhat similar to the range (Naidu et al., 1989) for 1988 (5-217 with only one value >85 ug/L). These generally low values would tend to indicate that phosphate is being rapidly utilized, particularly in surface waters with very limited build-up at depth where photosynthesis is markedly lower.

The total nitrogen to total phosphorus (TN:TP) ratio averaged 83 (1988 = 77) in July and 10 (1988 = 62) in February. The reduced February value is related to the high TP for that month discussed above. The reactive nitrogen reactive phosphorus ratio (RN:RP) was 90 in July and 67 in February clearly indicating that the dam was phosphorus limiting, a situation that has prevailed throughout the dam's history.

iii) Sulphur

Total sulphur values ranged from <0.1-8.3 mg/L with the surface waters generally having the lowest values. Any sulphur released by oxidation of organic matter is quickly taken up by biota and then carried downwards after death of the organisms.

iv) Total Iron and Manganese

Values continue to be low for both total and dissolved forms of these elements. Detectable amounts were usually only found in deep water with the exception of station 3 in February, this latter result probably being related to the shallow contact with oxygen free water. The general absence of iron and manganese in surface waters can be explained by the rapid oxidation of these elements there followed by precipitation as particulate matter.

4.2 The Wailoa River

Although the water exiting the power station has rapidly taken up oxygen, there were still detectable levels of soluble iron and manganese indicating that the complete oxidation and precipitation of these elements had not occurred before exiting the station. However, by the time the water reached Laselevu, concentrations of these elements had dropped below the detection limits of the methods used.

Levels of nutrients and seasonal variations in other parameters showed little change from previous years.

5) Invertebrate Survey

A fourth survey of the gastropods and other invertebrates in lake Monasavu was made on 10 July 1989.

The two sites previously visited were again surveyed. These were situated at (1) the end of the road (2) the dam edge. Both were in relatively shallow water where light can reach the substratum. Microscopic algae, on which gastropods feed, need light to photosynthesize.

As in 1988, the only gastropod found was the thiarid Melanoides tuberculata. Ten of these were dissected and one specimen (28 mm high) contained many trematode flukes (Platyhelminthes). These parasitic flukes are frequently found in M. tuberculata and it is thought that their other host is the cane toad. The fluke is not parasitic in humans.

The invertebrates found were :

Gastropoda	:	Melanoides tuberculata
Odonata	:	damselfly nymphs
		dragonfly nymphs
Trichoptera	:	2 species of caddisfly larvae
		(one species was using young M. tuberculata shells to build their cases)
Orthoptera	:	many small crickets at the dam edge
Plankton	:	Copepods (Crustacea) (were very abundant)
		one water mite

plant and insect parts that had fallen into the water.

CONCLUSIONS

Over the period covered by this report the general patterns of water quality in the Monasavu reservoir and Wailoa river were similar to those observed in previous years. In the warmer months, deeper waters are extremely oxygen deficient and this "reduced" water moves to the Wailoa power station where rapid oxygenation occurs followed by oxidation and precipitation of iron and manganese. The dam and river would appear to be phosphorus limited in terms of biological productivity as has been observed for many freshwater systems in the world.

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INSTITUTE OF NATURAL RESOURCES

APPENDIX I

Our Ref :

Your Ref :

Date : 11 April 1989

P.O. Box 1168, Suva, Fiji.
Telephone: 302403 (Director)
313900 Ext. 343, 374, 348, 339, 251
Telex : FJ2712 (Wateres)
: FJ2276
Fax : 300373
Cable : INR, University, Suva.

The General Manager
Fiji Electricity Authority
Private Mail Bag
LAUTOKA

Attention : Mr Hing Sue

Dear Sir

I write in response to your request for a quotation for water quality measurements in 1989. The quote is as follows for two sampling trips:

1.	Wailoa monitoring for pH, oxygen, iron, manganese, total P, S and N, nitrate, ammonia, phosphate and chlorophyll - laboratory charges	$ 500.00
2.	Reservoir monitoring for pH, oxygen, iron, manganese, total P, S and N, nitrate, ammonia, phosphate, alkalinity, clarity and chlorophyll - laboratory charges	$1,000.00
3.	Snail examination, weed examination and zooplankton survey	$ 350.00
	Staff sampling time (4 days)	$ 860.00
	Transport	$ 500.00
	Accommodation - FEA	
	Meals	$ 60.00
	Report preparation	$ 60.00
	TOTAL	$3,330.00

I hope this is satisfactory

Yours sincerely

Shamila Naidu
for DIRECTOR