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STATUS OF WATER QUALITY IN THE QAWA RIVER BEFORE THE SUGARCANE CRUSHING SEASON OF 1996

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by

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1. INTRODUCTION

BACKGROUND

The status of the Qawa river has been a long standing concern for the residents of Labasa. Its uncharacteristic colour, intolerable stench and depletion of fish resources is being attributed to the FSC mill which discharges its waste water into the lower reaches of the river.

Results obtained from the last trip (22 August, 1995) show BOD levels to be extremely high at the discharge site (site 3). Other sites, with the exception of site 4, was also seen to be grossly polluted according to the guidelines in Clark, 1986 (Tamata, 1996). Pollutants contained in the upper reaches of the river at high tide indicate that great volumes of water enter the river during the rising tide and reaches as far as Boubale/Urata which is 6 km upstream from the mill. Sewage pollution was evident from the very high total and faecal coliform counts recorded. The Qawa river is relatively shallow and no distinct stratification was apparent from the last visit, indicating it to be a well mixed river.

APPROACH

This report details the water quality of the Qawa river during May 1996 which was supplement to the monitoring exercise of 22nd August, 1995 (Tamata *et al.*, 1996). Though results obtained from the previous visit indicate the mill to be the major pollutant source, comparison with results obtained before crushing is necessary to make a comparison. An extra site was added to this second visit and this is located about 0.5 km downstream from the Government wharf on Labasa river. The purpose for this additional site was to generally compare water quality of the Labasa river and Qawa river. Total dissolved solids, total suspended solids, nutrients, metals and total phosphorus levels were found from the previous visit to be insignificant and thus analysis for these parameters were omitted in this visit.

2. WATER QUALITY ASSESSMENT OF THE QAWA RIVER

A team of two scientists from the Institute of Applied Sciences at the USP visited Labasa on 29th and 30th May, 1996 to carry out water quality testing of the Qawa river. The detailed work program is set out below.

Detailed work program by the IAS at Labasa on 29th - 30th May, 1996

Wednesday, 29th May

10.00 - 11.30 am :	Interviewed the Senior Fisheries Officer, Northern.
1.00 - 5.00 pm :	preliminary survey of the sampling sites.

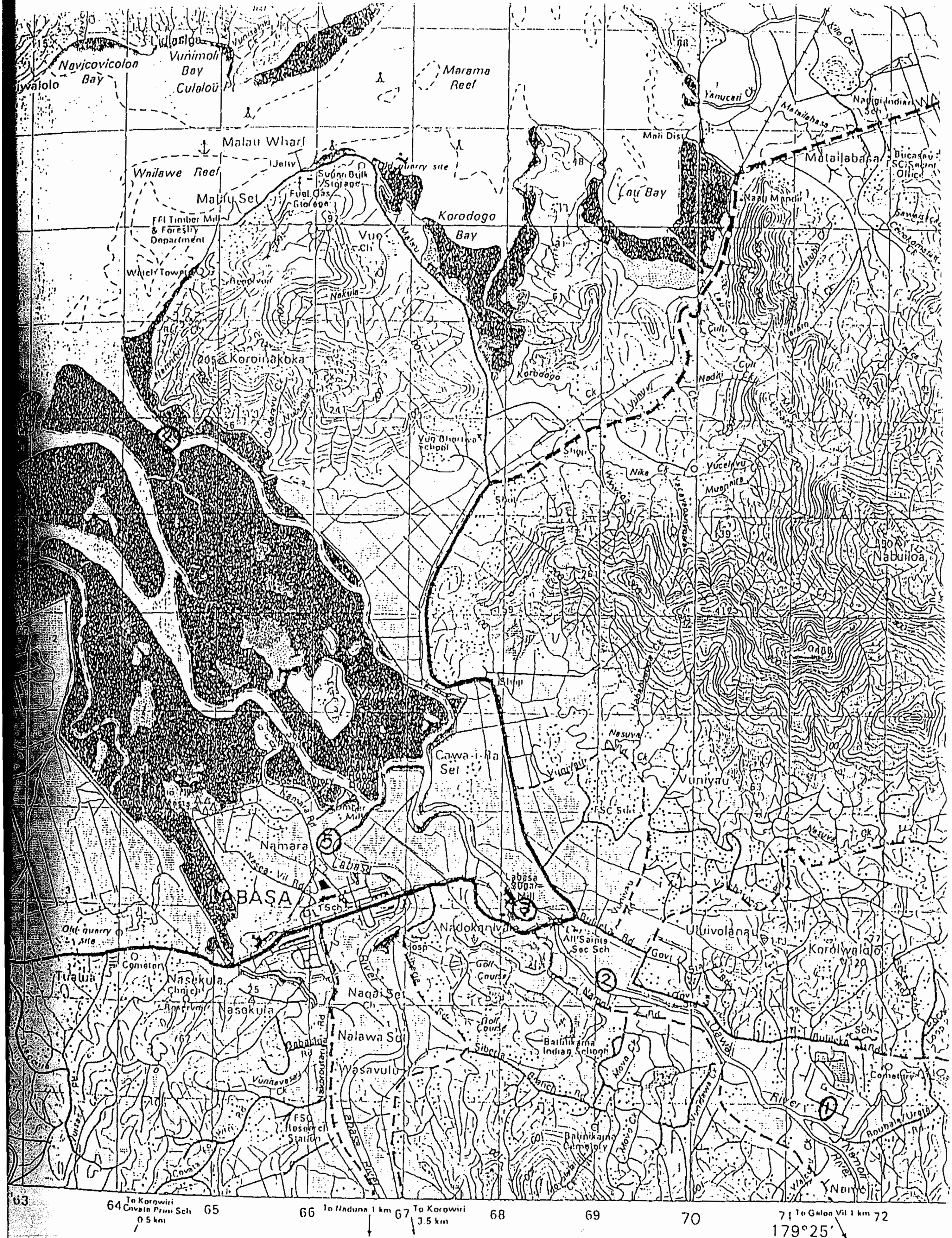
Thursday, 30th May

8.10 - 10.50 am :	Water quality testing and sample collection at low and receding tide. Samples collected from upstream site Boubale/Urata (Site 1) then proceeded downstream to site 2 at the Natokamu settlement, site 3 at the FSC mill site,at the river mouth (site) and finally site 5 which is 0.5 km down river from the Government wharf on Labasa river.
11.30 - 12.30 pm	Samples dispatched to Suva in ice
25 - 3.50 pm	Repeat water quality testing and sample collection at high and rising tide.
6.30 pm	Checked samples in at the IAS laboratory.

3. SITE LOCATION AND DESCRIPTION

Site 1	Boubale/Urata, 6 km upstream from FSC mill, boat difficulty during low tide, furthest point sampled
Site 2	Natokamu settlement, 1.8 km up from FSC mill site
Site 3	FSC mill site, pipes discharging cooling water into river
Site 4	River mouth, about 8.75 km downstream from FSC mill
Site 5	On Labasa river, about 0.5km downstream from the Government wharf

FIGURE 1. Locality Map of the Area.



4. METHODS

a) On-site measurements

On-site measurements included pH, salinity, water temperature and dissolved oxygen (DO) in the water. The pH was measured with an ORION Model 290A at two depths, surface and bottom. The salinity of the water at the surface and at the bottom was measured with a YSI Model 33 S-C-T Meter. Water temperature and dissolved oxygen at the surface and bottom were measured with the use of the YSI Model 51B DO meter.

b) Laboratory analyses

Water samples were collected from just below the surface and stored in ice for analysis in the laboratory.

i) *Organic constituents : Biochemical Oxygen Demand (BOD)*

BOD was measured by the 5-Day incubation method (APHA, 1981).

ii) *Microbiological assessment*

Microbiological analysis of the river water samples included counts of total liform and faecal coliforms. These were done by the Membrane-Filtration Method (APHA, 1981).

5. RESULTS

Results of measurements taken in the field during sampling are presented in Table 1 (low tide results) and in Table 2 (high tide results). The results of the laboratory analysis of water samples are presented in Table 3.

TABLE 1. **Analysis of Qawa River at Low Tide, 30th May, 1996.**

SITE #	TEMP. (°C)	SALINITY (ppt)	DISS. O_2 (mg/L)	pH	TIME
SITE 1				7.02	0810 hrs
Surface	25.0	1.1	4.2		
Bottom	25.0	1.1	3.9		
SITE 2				6.98	0850 hrs
Surface	26.0	11.0	2.9		
Bottom	26.0	22.0	0.6		
SITE 3				6.72	0905 hrs
Surface	26.8	14.2	2.6		
Bottom	27.1	20.8	0.2		
SITE 4				7.22	1000 hrs
Surface	27.5	29.5	2.5		
Bottom	27.0	32.0	3.1		
SITE 5				6.58	1050 hrs
Surface	28.0	17.0	4.8		
Bottom	27.5	18.0	3.7		

TABLE 2. Analysis of Qawa River at High Tide, 30th May, 1996.

SITE #	TEMP. (°C)	SALINITY (ppt)	DISS. O_2 (mg/L)	pH	TIME
SITE 1					
Surface	26.1	5.0	5.3	7.02	1325 hrs
Bottom	26.1	6.0	4.4		
SITE 2					
Surface	28.0	13.4	2.7	7.06	1345 hrs
Bottom	27.5	24.0	0.4		
SITE 3					
Surface	27.0	17.0	1.4	7.24	1415 hrs
Bottom	27.0	18.5	1.0		
SITE 4					
Surface	28.0	30.2	6.4	8.15	1505 hrs
Bottom	28.0	30.4	5.7		
SITE 5					
Surface	27.5	21.5	5.6	7.74	1550 hrs
Bottom	27.5	23.2	4.5		

Description		Low. Tide					High Tide				
						Labasa					Labasa
	Blank	Site 1	Site 2	Site 3	Site 4	Site 5	Site 1	Site 2	Site 3	Site 4	Site 5
Lab No.	96/647	96/648	96/649	96/650	96/651	96/652	96/653	96/654	96/655	96/656	96/657
Total coliforms (/100 mL)	0	13,800	17,300	9,000	8,000	16,300	16,200	9,000	11,500	800	18,000
Faecal coliforms (/100 mL)	0	270	330	230	22	290	410	350	310	10	450
BOD (mg/L)		0.7	0.9	0.9	0.5	0.8	3.0	2.0	1.5	0.6	0.7

TABLE 3. Laboratory Analysis of Qawa River, 30th May, 1996

a) On-site low tide results

Lowest tide was at 1020h. Sampling started at 0810h at Boubale/Urata, site 1. The last site (site 5) at the Labasa river was sampled at 1050h.

pH, temperature

pH ranged from 6.58 to 7.22. Temperature ranged from 25.0 to 28.0 °C. There was no significant difference between the surface and bottom water temperatures. Temperature was seen to increase by one degree celsius from site 1 to site 5.

Salinity, dissolved oxygen

Salinity was seen to be higher at the bottom than the surface except at site 1 where salinity was equal at both surface and bottom. This was because water was relatively very shallow at this site (1.5m). Site 4 was shown to have the greatest salinity (32.0 ppt) at the bottom where depth was greatest (5m). Some stratification is evident at sites 2 and 3. There was little stratification at sites 1, 4 and 5.

Dissolved oxygen (DO) concentrations ranged from 0.2 to 4.8 mg/L. DO concentration was highest at site 1 (4.2-3.9 mg/L) and high DO levels were also recorded at the Labasa river (site 5, 4.8-3.7 mg/L). Except for site 4, DO levels decreased at depth with the lowest DO level recorded at site 3 at 3m. Overall the DO levels recorded were below the recommended DO level (>6 mg/L) for a healthy aquatic life (CCREM, 1987).

b) On-site high tide results

Highest tide was at 1627 hours. Sampling started at site 1 at 1325 hours and continued downstream to site 5 which was sampled at 1550 hours. There were periods of light drizzle during sampling.

pH, temperature

pH range was slightly higher than that recorded during the ebbing tide. This range was from 7.02 to 8.15. The highest pH was recorded at site 4.

Water temperature was seen to be fairly constant with depth and with only a very slight increase from the morning sampling during the ebbing tide (**figure 2**).

Salinity, dissolved oxygen

As expected salinity was much greater at all sites as compared to the visit made during the ebbing tide (**figure** 3). Site 4 again recorded the highest salinity

(30.2-30.4ppt). Except for site 2, there was no distinct stratification throughout the water column. Salinity was however seen to be slightly greater at depth.

Dissolved oxygen increased slightly from the morning visit. Except for surface water at site 4, DO levels was still below the acceptable level (6 mg/L) as given in the CCREM guidelines (figure 4). Site 3 recorded the lowest DO level (1.4 mg/L) at the surface waters and there was only a slight decrease at depth. At site 2 DO levels decrease significantly from 2.7 to 0.4 with depth. The other sites also show DO levels to decrease with depth but not as significantly as in site 2.

c) Laboratory analysis results

i) Organic constituents: Biochemical Oxygen Demand (BOD)

BOD levels obtained during the ebbing tide were low and showed very little variation at all five sites. Values varied from 0.5 to 0.9 mg/L. The highest BOD during the ebbing tide was recorded at site 2 and 3 and the lowest was at site 4. BOD increased significantly during the rising tide at sites 1, 2 and 3 but remained almost constant at sites 4 and 5 (**figure 5**). BOD levels was highest at site 1 (3 mg/L) during the rising tide and decreased steadily downriver where at site 4 the lowest BOD level was recorded (0.6 mg/L). BOD at site 5 (Labasa river) was also low (0.7 mg/L). Except for the high BOD level at site 1 during the rising tide, BOD is < 2 mg/L at all sites during both tidal conditions.

ii) Total coliform, faecal coliform

Total coliform counts ranged from 8000 colonies/100mL (site 4) to 17300 colonies /100mL (site 2) during the ebbing tide. Samples taken during the rising tide show site 4 to still have the lowest total coliform count (800 colonies/100 mL) and the highest was at site 1 (16200 colonies/100mL) (**figure 6**). No apparent trend was noticed. Total coliform in the Labasa river was found to be extremely high during both tidal conditions with counts of 16300 colonies/100mL during low tide and 18000 colonies/100mL during high tide.

Faecal coliform (FC) counts ranged from 22 colonies/100mL (site 4) to 330 colonies/100mL (site 2) during the ebbing tide. Site 4 also recorded the lowest FC count (10 colonies/100mL) during the rising tide and the highest was recorded at site 1 (410 colonies /100mL). The Labasa river showed very high FC counts during the rising tide (450 colonies/100mL). Except for site 4, all sites showed an increase in faecal coliform during the rising tide. The increase was especially significant at sites 1 and 5.

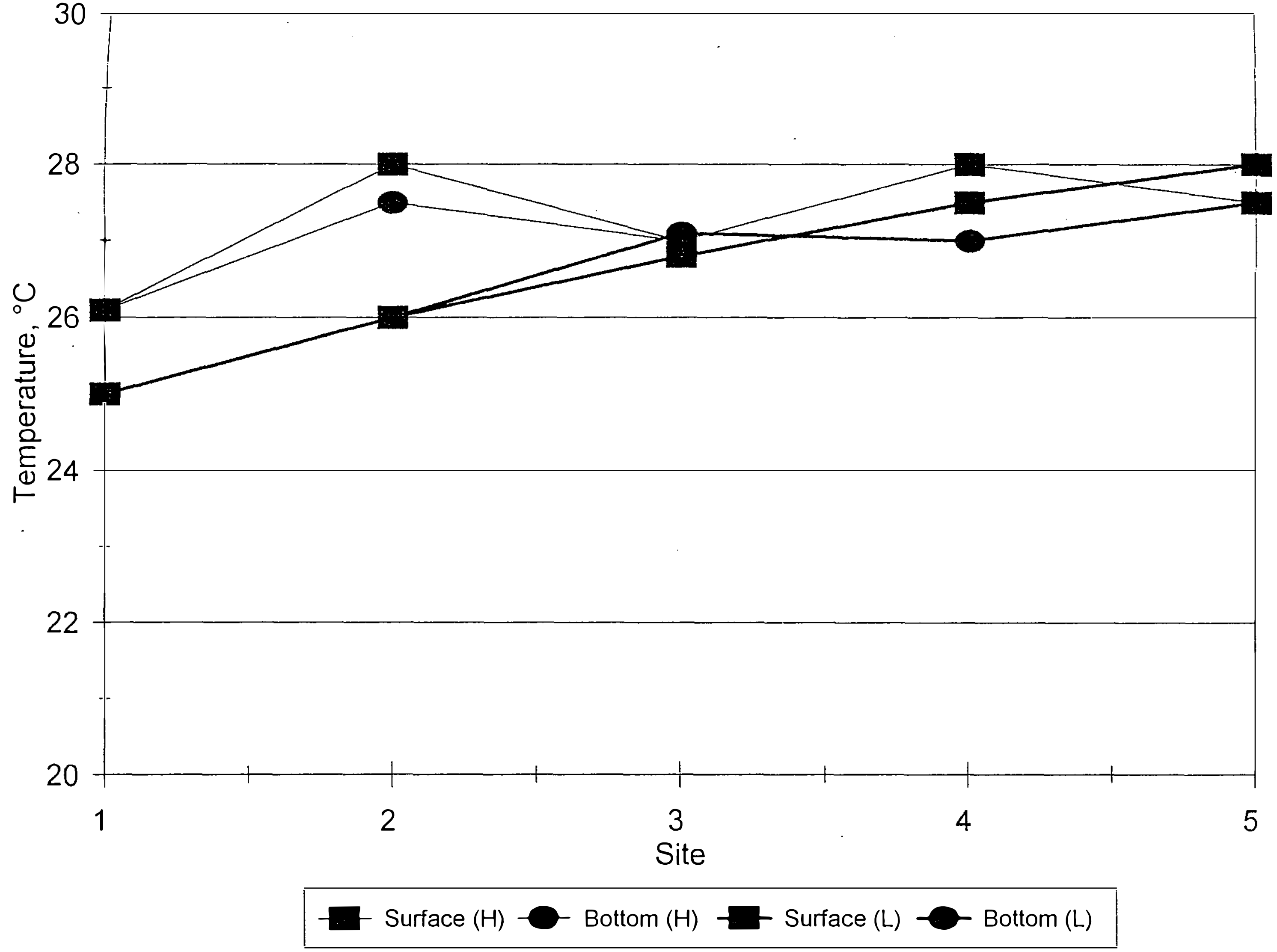


FIGURE. 2. Temp. along the Qawa River
30th May, 1996

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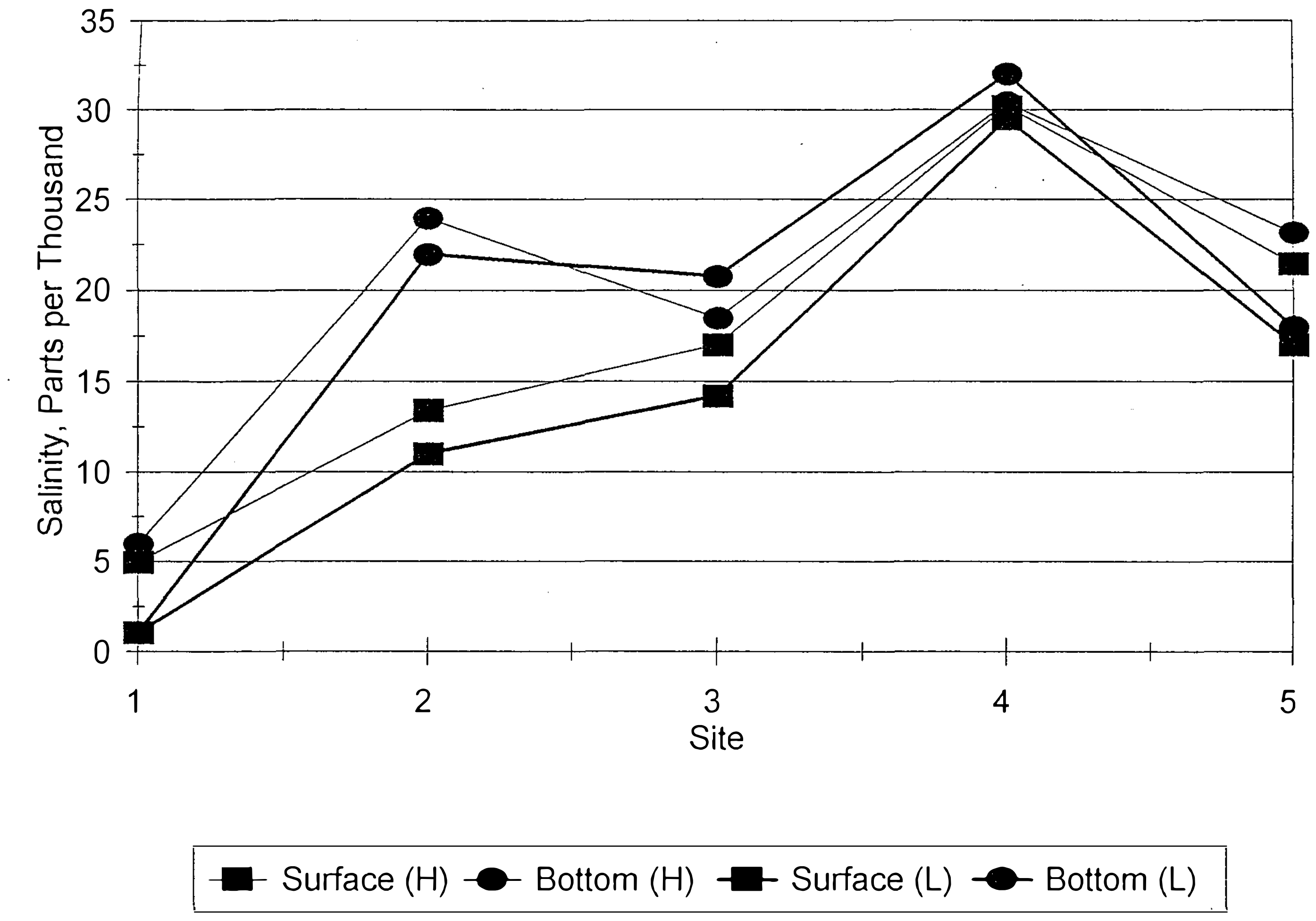

FIG 3. Salinity Along the Qawa River
30th May, 1996

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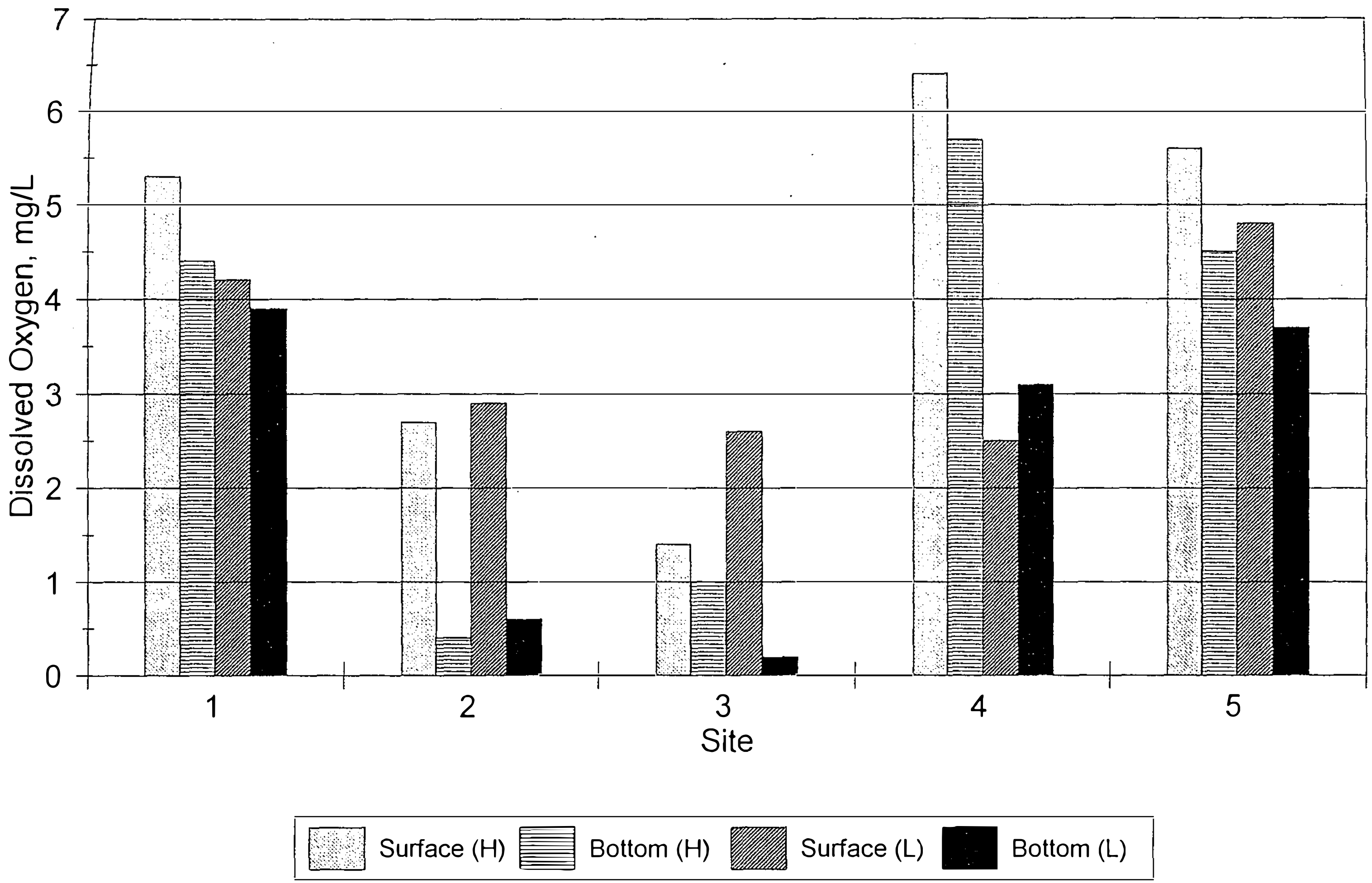

FIGUR E 4. D.O Along Qawa River
30th, May, 1996

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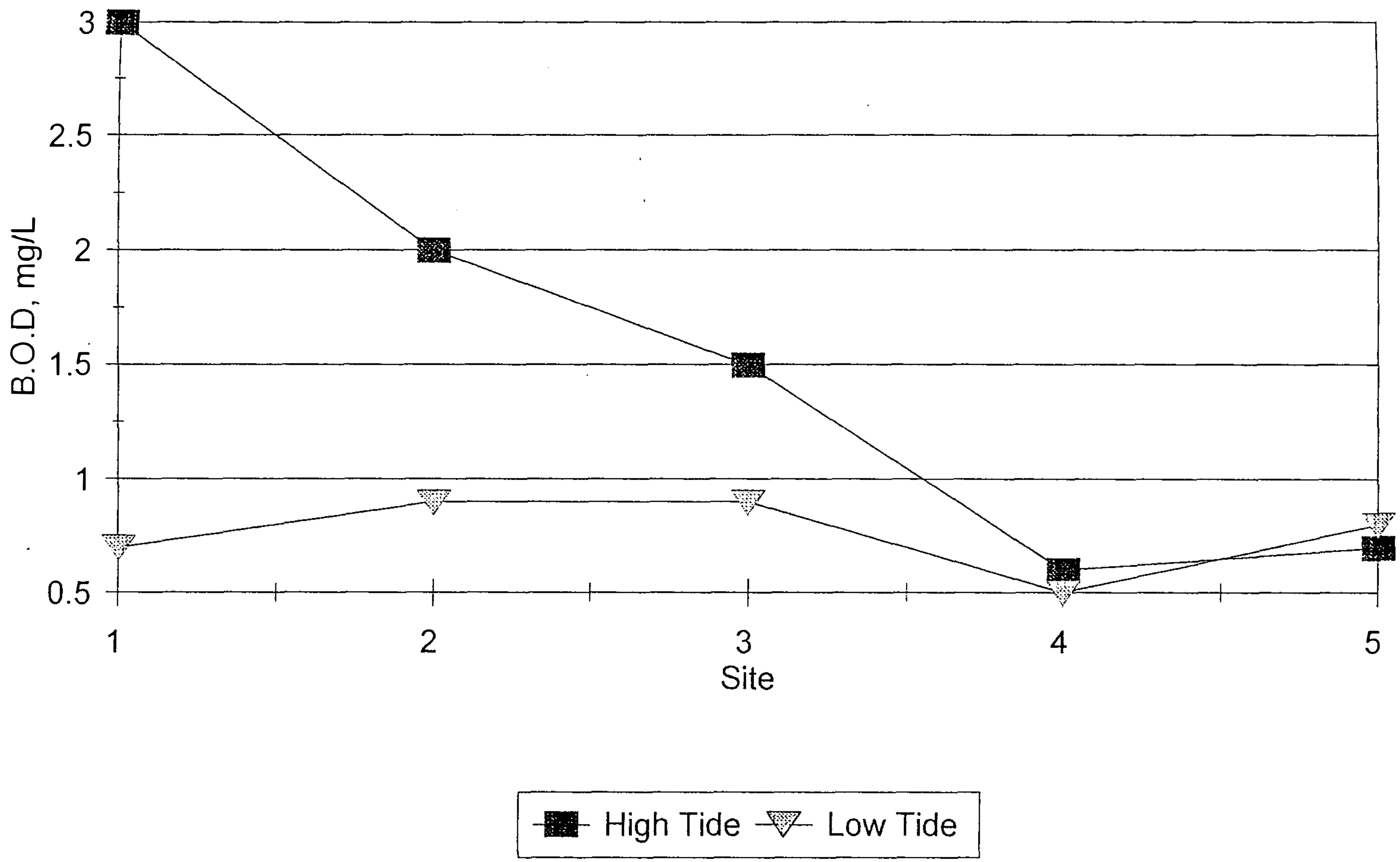

FIGURE 5. B.O.D Along the Qawa River
30th May, 1996

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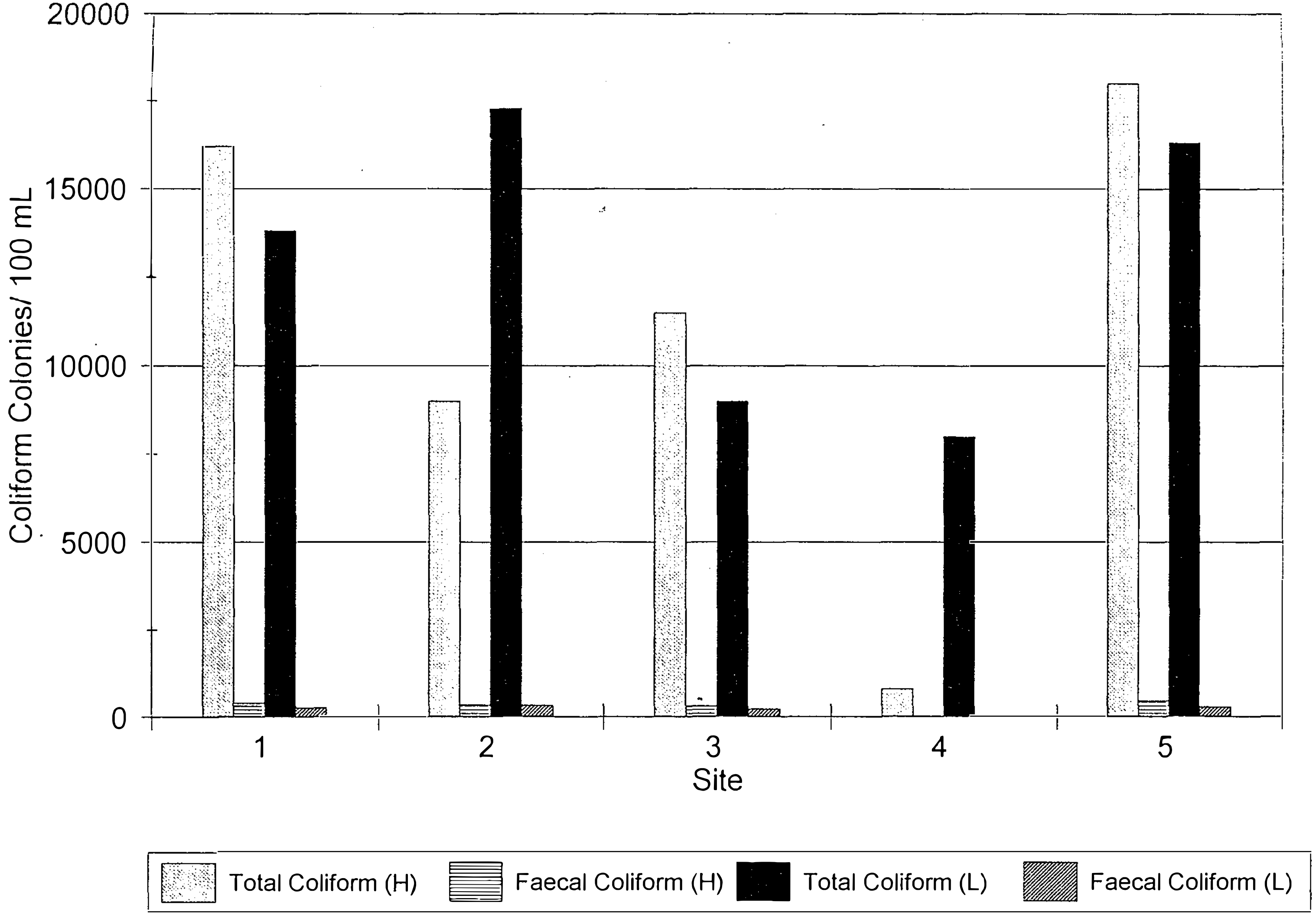

FIG. 6. Coliform Along the Qawa River
30th, May, 1996

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6. DISCUSSION

pH and water temperature

The pH values measured for the Qawa river is within the range of that expected in such a river (Clark, 1986). The pH of the river varies very little from that obtained during the crushing season suggesting that the pH of the discharge is not significantly different from that of the river.

Temperature is fairly constant with depth since the river is relatively shallow. Furthermore, during the incoming tide large volumes of water flow in ensuring turbulence. This contributes to the uniform temperature observed. During the crushing season temperature is higher at the point of discharge. The cooling water is several degrees warmer than the receiving water hence the higher temperature at the discharge site during crushing (Tamata, 1996). The discharge of cooling water into the river when the mill is not crushing is occasional and thus water temperature at the discharge site does not vary much from the adjacent sites during the non-crushing season.

Salinity, dissolved oxygen

At all sites salinity is relatively constant at depth. This results from turbulence. At high tide however, bottom waters have a slightly higher salinity and some form of stratification is evident. Incoming ocean waters are more dense thus this is underneath the less dense freshwater. This stratification does not occur in the shallower areas and is only clearly evident at site 2. Except for sites 2, 3 and 4 (during low tide) the DO levels are greater than 4 mg/L and considered by CCREM guidelines to be acceptable for healthy acquatic life (CCREM, 1987).

Dissolved oxygen recorded in this case show levels to be very low especially in the bottom waters of sites 2 and 3. At sites 2 and 3 DO levels were below 3mg/L throughout the tidal cycle with levels of <1 mg/L at the bottom. This is probably due to the huge piles of bagasse on either sides of the river in the vicinity of the mill. There was much more bagasse than the last visit. It was covering and killing (evident from the decrease in mangrove area) the mangroves fringing the river banks and spilling into the river. Bagasse is mostly cellulose and other plant material with some unextracted cane juice still present. Respiring bacteria and organisms feeding on the bagasse create an anaerobic environment. When anoxia develops, the degradation of carbon compounds slows significantly. Furthermore material which enters the river does not get properly flushed out to sea because of the gentle gradient of the river and its silty bottom (Nawadra, 1995). Thus bagasse is retained in the sediments at the bottom of the river for quite some time. The development and maintenance of anoxia is facilitated by continuous waterlogging of sediments and detritus (Furnass, 1992). The bottom of the Qawa river is most likely to be silty and covered with detrital material from the mangroves and raintrees fringing the river. This is probably responsible for the very low DO levels in the bottom waters at sites 2 and 3. Surface DO levels at site 2 and 3 are similar to levels during the crushing season. The previous survey showed bottom waters to be higher in DO than this recent survey. This may be a strong indication of the adverse effect of the bagasse incorporated into the sediments at the bottom of the river.

Organic constituents: Biochemical Oxygen Demand (BOD)

Biological oxygen demand (BOD) is a measure of the amount of oxygen that would be consumed if all of the organic matter in one litre of water were oxidised by bacteria in the water.

BOD during the ebbing tide was relatively low and fairly constant for all sites. During the incoming tide however, BOD increased at all sites and most significantly at site 1. The steady increase in BOD upriver during the rising tide indicate that pollutants are carried up as far as site 1 (Boubale/Urata). This was also observed in the previous survey (Tamata and Kubuabola, 1996).

BOD levels before crushing was much lower than during crushing. The last survey during the crushing season showed BOD levels to be significantly higher at site 3, the discharge site (> 12mg/L) than the other sites. This is not the case in this survey (before crushing) where at site 3 BOD levels are low (1.5 mg/L). The other sites also have BOD lower than levels during the crushing season. During the crushing season the mill site and Natokamu settlement were grossly polluted (Tamata,1996) but sampling during the non-crushing season showed these areas to be low in BOD. BOD concentrations during the non-crushing season show the river to be relatively unpolluted at levels below 2 mg/L (Clark,1986). These comparisons suggest the mill to be the major pollutant source during the cane crushing season.

Total coliform, faecal coliform

Though total coliform was very high, faecal coliform (FC) was within the WHO standards (<350 colonies /100 mL) with the exception of site 1 and 5 at high tide. The high FC count at site 1 during the incoming tide may be a result of the flow of pollutants upriver and its subsequent accumulation in the upper reaches of the river. Site 5 which is in the Labasa river showed highest total coliform and faecal coliform count. The sewage outfall is about 4 km downstream from the site.

Compared to the survey made during the crushing season, total coliform and faecal coliform is low. This lower coliform levels may be due to decreased turbidity and increase in predators which feed on these pathogens. The Qawa river is unusually turbid during the crushing season and this helps prolong FC half-life by shielding them from UV light and predators. Light is an important factor affecting the survival of bacteria (McNeill, 1992). When the mill is not crushing, however, water becomes less turbid and sunlight penetration into the water is greater hence a high die-off rate of FC.

7. CONCLUSION

Comparison of results obtained before and during crushing show the FSC mill to be directly responsible for the low DO levels and high BOD which are the indices of pollution. It would be misleading to conclude from the low BOD levels that the Qawa river during the non-crushing season is relatively unpolluted because the consolidation of the bagasse with the sediments at the bottom of the river would result in a slow but steady increase in BOD. The very low DO levels at sites 2 and 3 when the mill is not crushing indicate gross pollution by the bagasse dumped on the river banks. The presence of bagasse and the discharge of warm and high BOD waste water into the river during the crushing season would no doubtly drastically decrease oxygen availability to the few existing aquatic organisms in the river and discourage any recovery of the river. The turbidity of the river caused by the mill discharge prolongs faecal coliform survival and this contributes to the higher faecal coliform levels during the crushing season as compared to that during the non-crushing season. This higher faecal coliform survival during the crushing season could increase the risks of water-borne diseases during this season and can only be ascertained by comparing the frequency of the diseases before and during the crushing season.

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