FINAL REPORT

ON

MONITORING OF ENVIRONMENTAL STATUS OF SUBHAS SAROBAR, CALCUTTA AND PREPARATION OF MANAGEMENT ACTION PLAN

(01.08.1998 - 31.01.2000)

SUBMITTED TO

WEST BENGAL POLLUTION CONTROL BOARD
10A, LA BLOCK, SECTOR-III
SALT LAKE, CALCUTTA -700 091

SUBMITTED BY

INSTITUTE OF WETLAND MANAGEMENT AND ECOLOGICAL DESIGN
B-4, LA BLOCK, SECTOR-III
SALT LAKE, CALCUTTA -700 091

PROJECT INVESTIGATOR : - Mr. Tapan Saha.

PROJECT SCIENTISTS : -
1. Mrs. Shrabani som Majumder.
2. Mr. Nirmal kr. Manna.
3. Mr. Debojyoty Bhattacharyya.

PROJECT ADVISORS : -
1. Prof. Jyotirmoy Dutta.
2. Dr. Tarasankar Bandyopadhyay.

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Introduction:

Subhas Sarobar, under the administrative control of Calcutta Improvement Trust, represents the lung of East Calcutta with massive environmental fillip. The lake ecosystem is playing a key role in maintaining the oxygen balance and is also being used for sports, recreational and cultural activities. The vast water body and its two islands have also got potential for attracting the tourists. Moreover, this ecosystem is acting as a natural sink through the removal of pollutants from the surrounding environment.

Recently, the pressure of human activities on the Subhas Sarobar has increased manifolds. Over three thousand of peoples per day are using it for washing of clothes and utensils and for bathing. Solid wastes including plastic wastes are also being dumped beside the

lake water. All these anthropogenic activities have led to the deterioration of the environmental components specially the lake water quality. The environmental degradation consequently threaten the sustainable development of aquatic and terrestrial ecosystem of the area.

Considering its importance, the present investigation is being done to improve its overall quality.

Objectives:

The objectives of the present study is to assess the following parameters:

a) present environmental quality of the Subhas Sarobar complex including lake;

b) impact of present activities on the lake ecosystem;

c) to prepare a management action plan.

Material and Methods:

Nine sampling sites were earmarked for collection of monthly water samples during the study period. Samples for physico-chemical and biological analysis were collected from nine sites. Monthly values are presented as average of nine samples.

The surface water samples were collected by gently wading into the water in one liter of polythene cans. The pH, dissolved oxygen, conductivity and total alkalinity were estimated in the field. For other analysis the samples were taken to the laboratory and stored in refrigerator. The analysis was completed within 72 hrs following the standard methods (APHA,1992). Water temperature, turbidity, conductivity and pH were measured by an ordinary mercury thermometer, nephelometer, conductivity bridge and a water quality analyser (Elico make, Model PE-136). The dissolved oxygen was determined by modified Winkler's method. Total alkalinity was determined by titrating the sample against 0.1N HCl using methyl orange and phenolphthalein indicators respectively. Total solid was determined gravimetrically. Chemical oxygen demand was measured by refluxing the sample with $K_2Cr_2O_7$ and concentrated H_2SO_4 and then titrating the residual $K_2Cr_2O_7$ against ferrous ammonium sulfate using Ferroin as indicator. Surfactant was measured by LAS method (APHA 1992).

In case of heavy metal analysis water samples was first filtered using whatman -42 filter paper then it was heated nearly to dry. It was then digested with HNO_3-$HClO_4$ mixture (APHA) and were analysed Pb, Cd, & Cr, by AAS. Hg was determined by cold atomic mercury vapour absorption method (Model MA 5840, manufactured by Electronics Corporation of India Limited). Soil samples were collected from three points namely pt-1,pt-3 & pt-5, at an average depth of 35-40 ft. Soil were taken in a polythene bag to the lab. It was then air dried, grinded, oven dried and finally passed through 2mm sieve. Air dried samples were kept in refrigerator for determination of organic carbon, total nitrogen, and total phosphorous. Before air drying the pH and Ec of soil samples were measured. Oven dried samples were digested with HNO_3-$HClO_4$ (3:1 ratio). The digested samples were analysed for Pb, Cd, & Cr by AAS. Hg was determined by using cold mercury vapour absorption method by using same Hg-analyser.

Primary productivity was analysed by using "Light and Dark" bottle method of Gaarder and Gran (1927) and as recommended by Vollenweider (1969). The samples were suspended at 0.5 m depth successively upto 1.0 m for 4 hours. After completion of incubation period dissolved oxygen was fixed on the spot and estimated by Winkler's method (Welch, 1948). Sub-surface plankton samples were collected by bolting silk net (no.-25) by filtering 25 L of water and fixed with 5% formalin. The identification of plankton was done after Ward and Whipple (1959), Needham and Needham (1962), Bold and Wynne (1978), APHA (1992). Their numerical abundance was expressed as individuals per liter. Benthic samples from sediment of all sides of the lake were collected within 4 to 13 feet depth with the help of Ekman dredge (17.3 cm / 23.5 cm). The collections were sieved immediately through a 40 no. sieve (256 mesh per square cm) and the samples were preserved in 5% formalin and were sorted out species-wise. The identification was done after Ward and Whipple (1959), Needham and Needham (1962), Tonapi (1980), Fitter and Manual (1986) and APHA (1992). Their abundance was calculated as number of organisms per square meter.

Results:

Physico-chemical parameters of water

Physico-chemical parameters of the lake water were shown in table 1&2. From the table it was observed that during study period both temperature and turbidity show monthly variations. In August 1999 the temperature of the lake water was max.(34.9^0C ± 0) and in Jan 1999 it showed the minimum value(21.8^0C ± 0.33). The turbidity values was highest in August 1999 (15.3 NTU ± 5.3) and minimum in Feb 1999 (7.2 NTU ±1.9). pH value was highest in Aug 1999 (10 ± 0.23) and least in March 1999 (6.9 ± 0.18). Ec value was max in Aug 1998 (418 /cm ± 24.2) and least in Jan 1999 (318 /cm ±15). Value of TDS was max in June 1999 (390 mg/l ± 14.7) and minimum in September 1998 (212 mg/l ± 2.2). TSS showed highest in Sept.1998 (971.2 mg/l ± 40) and minimum in Nov.1998 (587.2 mg/l ± 45). Total solids was max. in April 1999 (1204 mg/l ± 29.1) and minimum in Nov.1998 (815.7 mg/l ± 150.7). Total alk. showed highest value in May 1999 (158 mg/l ± 22.5) and least value in Nov. 1998 (130 mg/l ± 4.6). Highest D.O. value was shown in May1999 (8.6 mg/l ± 0.4) and least in Nov.1998 (4.7 mg/l ± 0.4). B.O.D. value was highest in April 1999 (18.7 mg/l ± 1.8) and lowest in Feb.1999 (5.1 mg/l ± 4.6). C.O.D. value was highest in Aug 1998 (226 mg/l ± 15.8) and least in Dec. 1998 (75 mg/l ± 13.7). Total hardness value almost remained same through out the year. Surfactant value was highest in March 1999, (0.43 ± 0.2) and least in December 1999 (0.09 ± 0.2).

Nutrient values of the lake water were shown in table 3. Total N value was highest in Aug 1999 (21.5 mg/l ± 5) and least in Feb. 1999 (0.9 mg/l ± 0.3). Ammonia N showed max. value in Sept 1998 (1.2 mg/l ± 0.9) and minimum value July 1999 (0.22 mg/l ± 0.7). Nitrate -N value was highest in August 1998 (11.8 mg/l ± 3.5) and least in next August 1999 (0.02mg/l ± 0.01). Highest value of total P was shown in July 1999 (1.67 mg/l ± 0.8) and least in August 1999 (0.26 mg/l ± 0.07). Inorganic phosphate -P showed max value in March 1999 (1.27 mg/l ± 0.55) and min. value in Feb.1999 (0.23 mg/l ± 0.06). In Feb 1999 the total sulphate-S showed the max. value (17 mg/l ± 2.6) and in Aug 1998 the min. value (6.68 mg/l ± 1.86). Metals were shown in Table 4. Among the metals potassium showed very little fluctuation during the year. Highest potassium value was found in August 1999 (9.24 mg/l ± 0.54) and least was in Feb 1999 (4.67 mg/l ± 1.38). Highest iron value was observed in August (0.09 mg/l ± 0.07) and least value was found in May, June, August 1999. Lead was found through out the year in a very negligible amount. Value of Zinc was more or less constant through out the year. Hg, Cd, Cr, were found below the detectable limit.

Physico-chemical parameters of sediment:

Physico-chemical parameters of the sediments were shown in table 5. pH value was highest in Nov 1998 (7.5 ± 0.05) and least in July 1999 (6.0 ± 0.1). Ec value was maximum in May 1999 (433.3 μs/cm ± 4.7) and min. in June 1999 (393 μs/cm ± 6.20). Org. C. percentage was highest in July 1999 (2.0 ± 0.27) and least in Aug. 1998 (1.14 ± 0.03). Total N showed max. value in April 1999 (0.83 mg/kg ± 0.5) and min. in Nov. 1998 (0.32 mg/kg ± 0.06). Total P value was highest in Jan 1999 (0.33 mg/kg ± 0.09) and least in March 1999 (0.11 mg/kg ± 0.07).

Toxic and heavy metals are expressed in table. 6. Lead was found in appreciable amount almost through out the year. Hg, Cd, and Cr, was found below detectable limit.

Biological Features:

FLORA

Phytoplankton

Phytoplankton populations of Subhas Sarovar lake showed wide seasonal fluctuations throughout the year. Numerical abundance and seasonal fluctuations of phytoplankton populations were presented in table T1 and fig. F1 respectively. It has been found that the total number of phytoplankton varied between 1925 /litre and 12092 /litre with an average value of 7565 /litre. Cyanophyceae was the most dominant group (67.69%) followed by Chlorophyceae (26.4%) and Bacillariophyceae (6.9 %) as shown in fig. F2A. The numerical values of Cyanophycaea range from 1015 /litre to 6347 /litre with an average of 4195 /litre. Higher count of Cyanophyceae population is recorded in pre monsoon period being maximum in monsoon. Whereas the minimum value is observed in winter months. Similarly Chlorophyceae and Bacillariophyceae exhibited the same trend of their seasonal fluctuations as the Cyanophyceae. Qualitative abundance of Phytoplankton is given in table T2. *Microcystis* of Cyanophyceae showed exclusively dominant genera throughout the year and its concentration was higher during monsoon months. Other major species were *Volvox, Nitzschia, Navicula* and *Chorococcus.*

Macrophytes:

Qualitative estimation of various types of macrophytes and their distribution status were thiroughly investigated (table T3). It has been found that a submerged macrophytes *Vallisneria spiralis* was the exclusively dominant species throughout the year. Frequency of free floating species like *Pistia stratiotes, Lemna acquinoctiales* and facultative species like *Wedelia chinense, Oldenlandia corynbosa* and *Commelina benghalensis* were almost negligible. The species of *Alternanthera philoxeroides* and *Enydra fluctuans* were also dominant among emergent macrophytes.

FAUNA

Zooplankton:

Seasonal variations of Zooplankton showed (fig F3.) same trend as that of Phytoplankton. The maximum number of total Zooplakton was registered in monsoon (6696 /litre) while minimum in winter (3253 /litre). Rotifera was the most dominant group (86.4%) followed by Copepoda (9.84%) and Cladocera (5.76%) of the total Zooplankton (fig.F2B). The concentration of Rotifera populations were 387 /litre to 5700 /litre with an average of 3108 /litre, Copepoda populations were ranging from 719 /litre to 1448 /litre with an average of 1755 /litre and Cladocera with range value of 0 to 719 /litre with an average of 486 /litre (table.T4). All the three groups showed maximum population during monsoon while minimum during winter months. Different species of Zooplankton are enlisted in table T3. The species like *Brachionus*, *Keratella* of Rotifera, and *Diaptomus* of Copepoda were the major dominant species of Zooplankton.

Benthos:

Numerical abundance of benthic populations (table.T5) fluctuated between 491/m^2 and 4011/m^2 with and annual average of 2314/m^2. Seasonal variation of different groups of benthos was shown in fig F4. Gastropod mollusc showed their supremacy (68.73%) followed by Oligochaetes (29.35%). Bivalvia (0.68%) and Diptera (0.56%) exhibited poor performance (fig F2C). Different species of benthos are listed in table T2. It was found that *Bellamya bengalensis, Thiara tuberculata, Digniostoma cerameoboma* of Gastropoda; *Tubifex* sp. and *Branchiura sowerbyi* of Oligochaeta were the dominant species. Species of Gastropod mollusc were reached maximum number in monsoon. No species of Bivalvia was recorded in pre monsoon.

Major vertebrate groups:

A thorough investigation on major vertebrate groups composed of different species of fishes, amphibians and birds (T6). Among fishes thirteen species were identified of which Indian major carps rohu, catla and mrigal were dominant species. The air breathing fishes like *Heteropneustis fossilis* and *Clarias batrachus* were rarely found. Only two species of amphibia namely *Bufo melanostictus* and *Rana tigrina* were observed. Seven species of birds were found in lake area. It is important to mention that migratory birds were not found throughout the study period.

Primary productivity:

Month wise estimation of productivity values are given in T7. The gross primary productivity (GPP) and net primary productivity (NPP) values fluctuated between 510 - 1300 $mgC/m^3/hr$. and 270 - 1013 $mgC/m^3/hr$. respectively throughout the study period. The community respiration (CR) values ranged from 95 to 377 $mgC/m^3/hr$, being minimum in May'99 and maximum in June'99. Fig 8. Shows the seasonal fluctuation of primary productivity of the lake water. During study period the maximum gross primary productivity (GPP) and net primary productivity (NPP) values are 948.3$mgC/m^3/hr$ and 726.0$mgC/m^3/hr$ respectively in pre monsoon period. Minimum value is found 579.0$mgC/m^3/hr$ and 333.6$mgC/m^3/hr$ during winter.

<u>Discussion</u>: -

The pH value was highest in August 1999 (table-2). Two complementary reasons can be assigned for the high values are

1. input of nutrients carried by run off.
2. high phytoplankton population which can increase the pH.

Turbidity value depends upon the suspended particles present in water, therefore it can be a good index of phytoplankton population especially in productive water. The high value of turbidity in August 1999 (table 1) is probably due to high rate of surface run off to the lake water and also due to high planktonic growth in this season (Fig.4).

The high value of Ec and total dissolved solid in June 1999 (table 2) can be explained by the similar reason.

The maximum value of total suspended solid in September 1999 (table 2) and total solid in April 1999 (table 2) can be explained from the increased rate of surface run off, and high rate of evaporation and consequent decrease in water volume.

The high evaporation effect in lake water also increase the concentration of ions and thus increase the total alkalinity value of lake water in May 1999(table 2).

Dissolved oxygen (DO) was maximum in May 1999 (table-2). Least DO value was obtained in November 1998. The high value in May associated with high temperature and high planktonic growth in water. Relative high value in July 1999 is related to surface turmoil leading to increase dissolution of atmospheric oxygen and increased photosynthetic production of lake.

The BOD value of lake show fluctuations through out the season. The low BOD value in July, August etc can be explained from dilution effect. BOD value decreased abruptly from December 1998 to January 1998 probably due to cleaning of weeds from lake water. High value in April and May probably due to the presence of appreciable amount of biodegradable substances. The high COD value throughout the year in comparison to the BOD is due to the intense daily use of lake for washing and bathing purposes and throwing of non biodegradable matters. The value of surfactant was highest in March 1999 probably due to the same reason. Increased rate of washing and bathing was observed from March 1999 to August1999.

The higher concentration of nutrients particularly nitrogen and phosphorus are expected to be present in lake water. This lake also shows wide variations of these nutrients. In August 1999 total nitrogen reached a maximum value (table-3) probably indicating presence of substantial amount of organic matter both in form of leaving algal mass and detritus associated with higher temperature, turbidity and higher amount of phytoplankton population.

The ammonia nitrogen shows maximum value in September 1998 (table-3) associated with highest value of BOD. These value is probably due to ammonification as a result of decomposition of organic matter at higher temperature. Nitrate nitrogen values are gradually decreased from September 1998 to August 1999.The least value in august 1999 may be due to high dilution effect of monsoon.

Like nitrogen, phosphorus in different forms also takes part in algal growth and eutrophication. Highest value of total -P is encounter during July 1999 may be due to contribution by land run off from surrounding areas. Inorganic phosphate P showed highest value in March 1999 (table-3) may be due to high rate of washing as observed on that particular time.

The sulfate cycle in water was largely depend upon physico-chemical conditions and microbial activities prevailing there. Highest sulfate value in August 1999 (table-3) presumably due to land leaching as well as oxidation of organic sulfur in prevailing aerobic environment.

In this lake water the highest potassium value was found in August 1999 (table-4). The most probable cause of this was surface run off. This changes that was seen, was a background of almost constant inputs of organic and inorganic components due to daily washing and bathing practices, of not less than three thousands people daily. Considering other metals, only Lead was found in a very minute amount (table-4). This may be due to high anthropogenic activities in the lake.

Considering the sediment (table-5) parameters it was slightly acidic in nature. The sediment pH was much less than that of water. The Ec value was more or less high indicating the presence of much ions in sediment water suspension. The value of organic C% was very high indicating the presence of high amount of organic matter. From the table-5 it was clear that the sediment was also rich in phosphorus and nitrogen. This high value may be due to high human activities on the lake.

From the heavy metal study of the sediments it was shown only Lead was found. All the other three metals namely Hg, Cr and Cd were found below detectable limit. Presence of Pb supports the human activities on the lake.

Variations of different parameters with depth showed that at the depth increases the temperature of the lake water decreases and also the DO value. Down the lake pH value also changed from alkaline to acidic range. BOD, ammonia- N, sulphide- S values were increased showing the absence of oxygen. On the other hand nitrate- N, nitrite- N and sulphate-S values were decreased. Thus considering the change of different parameters with depth it can be said that the stratification is prevailing in the Subhas Sarobar lake.

. Growth and development of biological components depend upon the physical and chemical environment of the media where they grow. In the present investigation the influence of physico-chemical parameters on phytoplankton growth is well marked (table -T8). The Maximum growth of phytoplankton was recorded during pre-monsoon and monsoon months. This might be due to increased temperature ($r= 0.71$, $p>0.02$). Not only that but also the influence of different nutrients specially total alkalinity ($p>0.01$), total nitrogen ($p>0.1$), total phosphorus ($p>0.05$) on phytoplankton growth is significant. During monsoon ground water and surface water run off seams to be important for enriching in the lake water with nutrients. These factors possibly enhanced the maximum growth of phytoplankton in monsoon months. Dominance of *Microsystis* in lake water is indicative of rich nutrient status of the lake. It has been reported that *Microsystis* itself is a polluting agent, release obnoxious toxic substance into water.

Macrophytes play a very significant role in the ecology of all aquatic habitats. Succession and distribution of aquatic vegetation of Subhas Sarobar lake was thoroughly investigated. It is significant to mention that the lake was dominated by luxurient growth of a single species of submerged macrophyte *Vallisneria spiralis*. The other species which are very common in the gangetic region of West Bengal like *Hydrilla, Ottelia, Aponogeton, Najas* etc. were totally absent this lake. All littoral region covering about 35% to 40% of the lake water area provided with *Vallisneria* growth. Presence of only *Vallisneria* sp. and absence of other submerged macrophytes indicating some factors favouring *Vallisneria* growth and extinction of other species which required details study regarding ecology and behaviour of the species.

Observations reveal that the seasonal variations of zooplanktin in lake were parallel with the fluactuations of phytoplankton as the zooplankton graze on phytoplankton. Dominance of rotifers organisms among zooplankton is likely to be quite good as far as fish production is concerned.

Benthic organisms play a greater role in the food chain of aquatic ecosystem. In the present investigation benthic fauna was dominated by gastropod mollusc. Mollusc were distributed greatest in the littoral region. Their population density gradually declined from littoral zone to limnetic zone and were absent beyond 3.4 m depth. Contribution of gastropod mollusc was about 69.41% of total benthos, this may be due to aquatic vegetation specially submerged macrophytes in addition to deposited organic matters. Enrichment of sedimented organic matters from ground water and surface run off may favoured the maximum benthic growth and reproduction during monsoon.

In tropical climate light and temperature are highly favourable for sustainable high primary production. In the present study GPP and NPP values were higher in pre-monsoo and monsoon which were related to higher phytoplankton growth. According to Jorgensen's (1980) classification the Subhas Sarabor Lake is under a mesotrophic condition in general.

Proposal For Management Action Plan Of Subhas Sarobar:

The main factor causing deterioration of the subhas sarobar lake are

1. washing of the clothes and utensils
2. Bathing
3. Dumping of waste materials including religious offerings, immersion of idols etc.
4. Run off from washing of vehicles
5. Erosion of bank

In June 1999, Calcutta Metropolitan Development Authority (CMDA) and Calcutta Improvement Trust (CIT) jointly prepared a proposed Development & Upkeepment plan for Subhas Sarobar. After analysing the findings of our present study, it is felt that the plan prepared by CMDA & CIT is exhaustive and appropriate. Implementation of this plan will expected to improve the water quality of the Subhas Sarobar and the environmental condition of the total complex will be upgraded. In addition to their plan if following steps are taken there we believe the environmental and ecological management of the lake will be properly managed:

1. Restriction of dumping of garbage - mainly wastes generated from religious offerings
2. Ban on immersion of idols as because idols contain number of pigment, chemicals etc. which are non-biodegradable and as well as increases COD.
3. Washing of vehicles- industrial and municipal waste carrying vehicle , two wheeler, Car etc.
4. Bathing can not be allowed .

The water area should be restricted by construction of galvanized iron net fencing around the lake with the number of gates for Angling, swimming, Boating and other recreational and cultural activities. The gates will be controlled, manned and maintained by the respective organisations.

Awareness campaigns at regular interval are necessary among the local people for betterment of the environmental condition of the Subhas Sarobar Complex.

Pollution status of Subhas Sarobar

Studies on Subhas Sarobar through out the season revealed the following clues giving rise to an adverse effect on the ecology of the ecosystem.

- Total suspended solids are well above the threshold limit and restricts the penetration of sunlight only within three meters, the photic zone depth.
- The dissolved oxygen content in surface water are under-saturated during most of the time of the time of the year and thus, can not serve as potential source of pure oxygen supply to the environment.
- The appearance of an important physical event, thermal stratification during February to November, separates the water body into two distinct layers of epilimnion (lower dense strata) and hypolimnion (higher dense strata) with different physico-chemical characteristics. With the shift from and aerobic to an-aerobic hypolimnion, a large, often major volume of water is excluded from habitation by most animals and many plants. Another major change is the shift from aerobic to anaerobic bacterial metabolism which markedly reduces overall efficiency of decomposition of organic matter, gradually increasing the load of dissolved organic matter in the system.
- The ratio of BOD to COD is very low implying the presence of large amount of undergraded organic matter of refractory origin which imparts unusual color in water and restricts the penetration of sunlight and provides to prolifirate specific unusual biotic composition in the medium.
- N/P ratio in the present study is lower than that used by plankton, indicating comparatively higher amount of phosphorus in the medium. This enrichment of phosphorus encourage to dominate nitrogen fixing algae to balance the nutrient ratio. The occurrence of Cyanophyceae at about 68% of total population through out the year along with genera of Microsystis, Anabaena, Chorcoccus and Oscillatoria are indicative of organic pollution and eutrophic condition in the medium.
- Similarly the presence of dominating group of Rotifera (86%) among the fauna together with genera Brachionus, Keratella, Fillinia and Polyarthra, also support the existence of organic pollution and eutrophication in the medium.
- The population density of benthic ortanism, dominated by gastroped molluse only, decreased from littoral zone to limnetic zone and were completely absent beyond 3.4 m depth. This

collaborated with the previous findings that above this depth due to presence of unhygienic condition it is very difficult for the animals to survive.

- Considering total average depth in Subhas Sarobar as 12 m it can be inferred that about 65% of total value of water is unsuitable for the occurrence of common plant an animals through our the year, may be due to the presence of toxic gases of H_2S at low pH and anoxic condition in the lower strata
- The levels of trace metals are very low in surface water and almost absent in sediments excepting with only Pb of below 1.0 ppm level. Since sediments are recognised as trapping area of suspended and detritus matter from the overlying water, hence deposition must be taking place but the anoxic condition prevailing at the sediment-water interface with lower pH of the soil-suspension, encourage the mobilisation of associated trace metals to the large volume of overlying water bringing about significant dilution. This phenomena prevents the metals from enrichment in the sediments. Thus, Subhas Sarobar is seemed to be free from trace metal pollution in water as well as in the sediments.

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Table-1
Physical parameter of lake water
(Values are given in an average of nine samples)

Months	Temperature(^{0}C)	Turbidity(NTU)
August 1998	30.3 ± 0.47	8.5 ± 1.3
September 1998	34 ± 0	8 ± 0.9
October 1998	31 ± 0	8.5 ± 1.3
November 1998	27 ± 7.14	9.5 ± 1.5
December 1998	25.6 ± 0.46	9.4 ± 1.5
January 1999	21.8 ± 0.33	9.8 ± 1.6
February 1999	25 ± 0.08	7.2 ± 1.9
March 1999	29.6 ± 0.47	9.8 ± 1.0
April 1999	33 ± 0.20	9.3 ± 1.4
May 1999	33.4 ± 0.08	9.2 ± 1.2
June 1999	33.9 ± 0.15	9.7 ± 1.5
July 1999	34.7 ± 0.16	13.5 ± 1.8
August 1999	34.9 ±0	15.3 ± 5.3

Table-2
Chemical parameters

Months	pH	Ec (μs/cm)	TDS (mg/l)	TSS (mg/l)	TS (mg/l)	Total alk. (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Total hardness (mg/l)	Surfactant (mg/l)
August 1998	8.2 ± 0.08	418 ± 24.2	352 ± 11.8	804 ± 60.4	1155 ± 58.9	108 ± 9.1	5.0 ± 0.62	12.3± 4.7	226±15.8	55±3.8	0.14± 0.3
September 1998	8.4 ± 0.28	370.3 ± 27.6	212 ± 2.2	971.2 ± 40	1183 ± 37.7	136 ± 4.2	5.6 ± 1.6	12.5± 3.6	167±19.9	53±2.4	0.17±0.4
October 1998	8.5 ± 0.28	361.2 ± 21.0	316 ± 26	792 ± 44.3	1110 ± 47.6	132 ± 12	5.7 ± 1.7	13.2± 3.8	141±9.6	52±2.2	0.13±0.2
November 1998	7.7 ± 0.13	371 ± 15.4	228 ± 15	587 ± 45	815.7 ± 15.	103 ± 4.6	4.7 ± 0.4	12.7± 6.4	131±16.8	51±12.3	0.10± 0.3
December 1998	7.3 ± 0.16	338 ± 20.2	238 ± 22.9	838 ± 57	1058± 59.7	103 ± 4.7	6.0 ± 0.8	15.4± 2.5	75±13.7	70±12.6	0.09± 0.2
January 1999	7.3 ± 0.15	318 ± 15	287 ± 26.9	615 ± 31.2	890 ± 43.7	113 ± 40.4	6.9 ± 0.6	9.1± 2.2	93±20.3	51±6.2	0.09± 0.3
February 1999	8.4 ± 0.24	332 ± 6.7	224 ± 7.5	686 ± 5.8	1013 ± 11.3	122 ± 10.5	6.2 ± 1.9	5.1± 4.6	127±23.9	52± 9	0.12± 0.5
March 1999	6.9±0.18	350±12.2	334±1.17	769.5±41.	1093±45.6	113 ± 10.1	6.6 ± 0.5	7.1± 2.0	121±44.3	72±2.4	0.43± 0.2
April 1999	8.1±0.52	385±9.18	360±15.5	843.2±19.	1204 ± 29.1	117 ± 8.6	5.4 ± 1.1	18.7±1.8	124±27.6	59±10.5	0.37± 0.5
May 1999	8.6 ± 0.46	402 ± 5.2	361±13.6	697.5±17.	1164 ± 37.2	158 ± 22.5	8.6 ± 0.4	16 ± 7.7	125±38	47±5.1	0.39± 0.1
June 1999	8.6 ± 0.33	422 ± 5.9	390±14.7	626.2±10.	918 ± 11.2	147 ± 6.5	8.1 ± 0.5	6.9 ± 0.9	107±20.4	69±7.5	0.25± 0.3
July 1999	9.0 ± 0.27	361 ± 16.8	290±5.4	692.8± 36	997 ± 35.9	144 ± 14	7.6 ± 0.2	7.6 ± 1.2	102±14.4	67±5.7	0.32± 0.2
August 1999	10 ± 0.23	385 ± 5.2	304±4.1	830±16.7	1191 ± 30.7	126 ± 3.3	6.7 ± 0.6	8.1 ± 1.1	95 ± 12.1	64±13.4	0.28± 0.5

Table-3
Nutrient value

Months	Total -N(mg/l)	NH_3-N(mg/l)	NO_3 -N(mg/l)	Total _-P(mg/l)	Inorg -PO_4-P	Total SO_4 -S(mg/l)
August 1998	4.7 ± 0.6	0.94 ± 0.8	1.8 ± 0.5	1.67 ± 0.2	0.52 ± 0.2	6.68 ± 1.86
September 1998	5.4 ± 1.3	1.2 ± 0.9	0.6 ± 1.7	1.0 ± 0.68	0.38 ± 0.5	6.80 ± 3.18
October 1998	4.5 ± 0.7	0.35 ± 0.2	0.5 ± 1.7	1.0 ± 0.18	0.35 ± 0.1	6.82 ± 3.1
November 1998	4.4 ± 0.8	0.2 ± 0.02	0.2 ± 0.4	1.4 ± 0.19	0.49 ± 0.06	7.62 ± 0.5
December 1998	2.3 ± 0.7	0.35 ± 0.03	0.1 ± 0.3	0.56 ± 0.09	0.28 ± 0.05	7.34 ± 0.51
January 1999	1.9 ± 0.7	0.22 ± 0.05	0.75 ± 0.5	0.65 ± 0.34	0.27 ± 0.06	7.42 ± 0.35
February 1999	0.9 ± 0.3	0.1 ± 0.1	0.12 ± 0.06	0.65 ± 0.46	0.23 ± 0.06	17 ± 2.6
March 1999	1.8 ± 1.5	1.2 ± 0.8	0.17 ± 0.06	2.6 ± 0.9	1.27 ± 0.55	7.51± 0.22
April 1999	1.5 ± 0.8	0.59 ± 0.31	0.35 ± 0.19	0.94 ± 0.54	0.43 ± 0.16	7.18 ± 3.1
May 1999	1.1 ± 0.3	0.24 ± 0.07	0.27 ± 0.08	1.10 ± 0.4	0.61 ± 0.05	7.18 ± 0.7
June 1999	1.6 ± 0.4	0.31 ± 0.1	0.19 ± 0.05	1.17 ± 0.9	0.32 0.19	8.54 ± 1.0
July 1999	1.5 ± 0.6	0.22 ± 0.7	0.35 ± 0.09	1.67 ± 0.8	0.45 ± 0.17	7.01 ± 0.71
August 1999	21.5 ± 5	1.62 ± 0.31	1.08 ± 0.01	0.26 ± 0.07	0.25 ± 0.07	13.3 ± 2.2

Table –4
Metals

Months	Potassium (mg./l)	Iron (mg/l)	Lead (mg/l)	Zinc (mg/l)	Mercury (mg/l)	Chromium (mg/l)	Cadmium (mg/l)
August 1998	6.25± 0.77	0.09 ± 0.37	0.0044 ± 0.02	0.01 ± 0.01	BDL	BDL	BDL
September 1998	6.23 ± 0.86	0.06 ± 0.01	0.0281 ± 0.01	0.02 ± 0.02	BDL	BDL	BDL
October 1998	7.83 ± 0.92	0.09 ± 0.04	0.0134 ± 0.01	0.02 ± 0.02	BDL	BDL	BDL
November 1998	8.27 ± 1.75	0.07 ± 0.01	0.0346 ± 1.3	0.01 ± 0.01	BDL	BDL	BDL
December 1998	5.51 ± 1.09	0.04 ± 0.02	0.0222 ± 0.03	0.01 ± 0.01	BDL	BDL	BDL
January 1999	6.70 ± 2.4	0.03 ± 0.02	0.0106 ± 0.03	0.01 ± 0.01	BDL	BDL	BDL
February 1999	4.64 ± 1.38	0.02 ± 0.02	0.0321 ± 0.03	0.01 ± 0.01	BDL	BDL	BDL
March 1999	5.70 ± 0.56	0.02 ± 0.01	0.0422 ± 0.03	BDL	BDL	BDL	BDL
April 1999	5.97 ± 0.87	0.04 ± 0.02	BDL	0.02 ± 0.01	BDL	BDL	BDL
May 1999	6.74 ± 0.6	0.01 ± 0.01	BDL	0.03 ± 0.01	BDL	BDL	BDL
June 1999	6.72 ± 0.5	0.01 ± 0.01	BDL	0.01 ± 0.01	BDL	BDL	BDL
July 1999	8.96 ± 0.43	0.02 ± 0.01	BDL	0.02 ± 0.01	BDL	BDL	BDL
August 1999	9.24 ± 0.54	0.01 ± 0.01	BDL	0.02 ± 0.02	BDL	BDL	BDL

B.D.L.= Below Detectable Limit

Table-5
Physico -chemical parameters of sediments

Months	pH	Ec (μs/cm)	Organic carbon (%)	Total –N (mg/g)	Total -P (mg/g)
August 1998	6.4 ± 0.25	415.6 ± 0.02	1.14 ± 0.03	0.57 ± 0.06	0.18 ± 0.04
September 1998	6.2 ± 0.1	415 ±21.7	1.19 ± 0.01	0.34 ± 0.04	0.20 ± 0.01
October 1998	6.2 ± 0.1	426 ± 11.5	1.2 ± 0.04	0.42 ± 0.13	0.26 ± 0.06
November 1998	7.5 ± 0.05	422 ± 8.3	1.16 ± 0.05	0.32 ±0.06	0.24 ± 0.06
December 1998	7.2 ± 0.0	411 ± 4.6	1.27 ± 0.03	0.71 ± 0.09	0.28 ± 0.04
January 1999	6.6 ± 0.4	409 ± 6.1	1.17 ± 0.04	0.60 ± 0.09	0.33 ± 0.09
February 1999	6.3 ± 0.3	415 ± 0.00	1.93 ± 0.53	0.61 ± 0.02	0.22 ± 0.04
March 1999	6.0 ± 0.5	396 ± 11	1.82 ± 0.38	0.55 ± 0.21	0.11 ± 0.07
April 1999	6.5 ± 0.5	413 ± 3.0	1.35 ± 0.38	0.83 ± 0.5	0.13 ± 0.01
May 1999	6.8 ±0.2	433.3 ± 4.7	1.22 ± 0.14	0.57 ± 0.05	0.24 ± 0.05
June 1999	6.1 ± 0.1	393 ± 6.2	1.21 ± 0.07	0.81 ± 0.2	0.18 ± 0.03
July 1999	6.0 ± 0.1	425 ± 2.0	2.0 ± 0.27	0.7 ± 0.21	0.18 ± 0.01
August 1999	6.3 ± 0.3	414 ± 8.5	1.2 ± 0.05	0.63 ± 0.07	0.18 ± 0.04

Table 6
Toxic and heavy metal status of the sediments.

Months	Lead (mg/kg)	Mercury (μg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)
August 1998	0.37 ± 0.04	BDL	BDL	BDL
September 1998	1.4 ± 0.2	BDL	BDL	BDL
October 1998	0.42 ± 0.04	BDL	BDL	BDL
November 1998	0.52 ± 0.04	BDL	BDL	BDL
December 1998	0.33 ± 0.09	BDL	BDL	BDL
January 1999	0.35 ± 0.06	BDL	BDL	BDL
February 1999	BDL	BDL	BDL	BDL
March 1999	0.01 ± 0.01	BDL	BDL	BDL
April 1999	0.24±0.08	BDL	BDL	BDL
May 1999	0.19 ± 0.05	BDL	BDL	BDL
June 1999	0.01 ± 0.08	BDL	BDL	BDL
July 1999	0.44 ± 0.06	BDL	BDL	BDL
August 1999	0.51 ± 0.10	BDL	BDL	BDL

BDL = Below detectable limit.

Table-7
Depth wise variations of different parameters of lake water.

Months	Depth (ft)	Temp (^0C)	PH	DO (mg/l)	BOD (mg/l)	NH_4 - N (mg/l)	NO_3-N (mg/l)	NO_2 -N (μg/l)	Sulphide-S (mg/l)	Sulphate -S (mg/l)
February 1999	Surface	25.1	8.7	13.6	3.0	0.09	0.09	30.8	0.00	15.6
	5.0	23.7	8.1	12.4	4.0	0.18	0.01	18.2	0.01	12.8
	10.0	22.6	7.2	6.0	6.2	0.72	0.00	11.9	0.03	9.6
	25.0	21.9	7.0	4.0	9.7	1.03	0.00	4.8	0.09	6.2
March 1999	Surface	27	8.6	5.6	8.0	0.55	0.05	22.3	0.00	14.9
	5.0	23	7.5	4.0	8.7	0.30	0.08	16.4	0.01	11.3
	10.0	21	6.7	2.4	9.1	1.88	0.00	7.0	0.04	9.1
	20.0	18	6.5	1.2	9.7	1.47	0.00	5.5	0.08	3.2
	25.0	17	5.8	1.0	10.2	2.32	0.00	4.3	0.09	1.5
June 1999	Surface	32.7	7.0	9.2	8.4	0.38	0.05	28.9	0.00	15.6
	5.0	32.5	7.1	8.7	9.8	0.64	0.04	20.5	0.02	14.2
	10.0	32.3	6.9	7.5	9.6	0.72	0.03	17.2	0.02	13.9
	15.0	32	6.8	6.6	10.2	1.03	0.01	12.8	0.04	9.8
	20.0	28.5	6.6	3.1	15.8	2.08	0.01	9.7	0.06	7.6
	25.0	27.5	6.7	2.8	16.1	5.29	0.01	6.3	0.06	5.4
July 1999	Surface	33.6	9.0	7.8	5.6	0.56	0.01	45.6	0.00	10.2
	5.0	33.2	8.8	6.5	6.4	1.10	0.04	17.6	0.05	9.6
	15.0	32.9	8.7	4.7	7.0	1.18	0.03	11.8	0.06	7.5
	25.0	30.7	7.8	2.9	7.1	2.58	0.01	9.6	0.08	6.8

Table-8: Seasonal variations of some physico-chemical parameters of Subhas Sarovar lake water

Season	Temp(°C) (mean ± SD)	Turbidity (NTU) (mean ± SD)	pH (mean ± SD)	Conductivity (μs/cm) (mean ± SD)	Total Hardness (mg/l) (mean ± SD)
Post Monsoon	31.6 ± 1.7	8.3 ± 0.5	8.3 ± 0.48	365 ± 4.65	52 ± 2
Winter	24.3 ± 1.7	9 ± 0.81	7.7 ± 0.5	328 ± 12	54.3 ± 6
Pre Monsoon	32 ± 2.1	8.7 ± 0.5	7.7 ± 0.5	375 ± 20	64 ± 6
Monsoon	34 ± 0.82	12.7 ± 3	9.2 ± 0.6	386 ± 30	66.3 ± 3

Season	Total Alkalinity (mg/l) (mean ± SD)	Dissolved Oxygen (mg/l) (mean ± SD)	Total Nitrogen (mg/l) (mean ± SD)	NH_3-N (mg/l) (mean ± SD)	Total Solid (mg/l) (mean ± SD)
Post Monsoon	124 ± 15	5.3 ± 0.6	4.9 ± 0.5	0.53 ± 0.4	1053 ± 135
Winter	118 ± 10	5.8 ± 2.6	1.8 ± 0.6	0.1 ± 0.08	1008 ± 83
Pre Monsoon	117 ± 2.5	6.1 ± 0.5	1.8 ± 0.3	0.46 ± 0.2	1069 ± 131
Monsoon	151.4 ± 6	8.0 ± 0.4	12.5 ± 8.2	0.43 ± 0.17	1023 ± 106

Season	Total - Phosphorus (mg/l) (mean ± SD)	Sulfate (mg/l) (mean ± SD)	Potassium (mg/l) (mean ± SD)	BOD (mg/l) (mean ± SD)	COD (mg/l) (mean ± SD)
Post Monsoon	1.13 ± 0.2	7.3 ± 0.31	6.2 ± 0.8	12.3 ± 10	144.3 ± 17.3
Winter	0.63 ± 0.05	7.7 ± 0.3	4.8 ± 0.6	10 ± 3	106.6 ± 17.1
Pre Monsoon	0.83 ± 0.37	8.4 ± 0.8	6.5 ± 0.5	21 ± 15	122 ± 6.0
Monsoon	1.93 ± 0.95	11.5 ± 2.6	8.8 ± 1.3	6.6 ± 1.2	97.7 ± 7.6

Table - 9: Heavy metals present in lake water

Season	**Lead (mg/l)**	**Chromium (mg/l)**	**Mercury (mg/l)**
Post Monsoon	0.01	B.D.L.	B.D.L.
Winter	0.02	B.D.L.	B.D.L.
Pre-Monsoon	0.03	B.D.L.	B.D.L.
Monsoon	B.D.L.	B.D.L.	B.D.L.

B.D.L. = Below Detectable Limit

Table. 10 Quantitative abundance of phytoplankton (No/L).
(Values are given in an average of nine samples).

Months	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Total
August'98	6135	4953	1002	12090
September'98	4859	3308	1164	9331
October'98	4430	2646	308	7384
November'98	2104	1330	111	3545
December'98	1015	855	55	1925
January'99	2109	1064	187	3360
February'99	4270	2065	390	6725
March'99	5047	3594	1012	9653
April'99	4016	2070	927	7013
May'99	4846	2930	1012	8788
June'99	5159	3360	1115	9634
July'99	6347	3976	1013	11336

Table. 11 Quantitative abundance of zooplankton (No/L).
(Values are given in an average of nine samples).

Months	Rotifera	Cladocera	Copepoda	Total
August'98	3620	2183	1970	7773
September'98	3232	732	1448	5412
October'98	4015	47	906	4968
November'98	1456	308	1338	3102
December'98	387	187	760	1334
January'99	3330	22	1300	4652
February'99	1935	270	1575	3780
March'99	4197	355	2140	6692
April'99	2507	12	887	3396
May'99	3306	38	719	4063
June'99	3615	112	840	4567
July'99	5700	150	1900	7750

Table. 12 Quantitative abundance of macrozoobenthos (No/L).
(Values are given in an average of nine samples).

Months	Gastropoda	Bivalvia	Oligochaeta	Diptera	Total
August'98	2377	6	281	NF	2664
September'98	394	6	85	6	491
October'98	1749	NF	883	8	2640
November'98	1375	NF	943	NF	2318
December'98	769	NF	465	6	1240
January'99	719	NF	598	NF	1317
February'99	917	NF	525	NF	1442
March'99	3318	NF	568	NF	3886
April'99	1692	NF	468	NF	2160
May'99	1993	NF	529	NF	2522
June'99	3518	NF	492	NF	4010
July'99	2682	NF	314	NF	2996

NF = Not Found

Table: - 13 Estimation of primary productivity (MgC / m^3/ hr).

Months	Gross Primary Production (GPP)	Net Primary Production (NPP)	Community Respiration (CR)
August'98	1300	1013	287
September'98	932	720	212
October'98	648	421	227
November'98	578	293	287
December'98	510	270	240
January'99	589	311	278
February'99	638	420	218
March'99	956	628	274
April'99	873	575	298
May'99	1016	921	95
June'99	782	405	377
July'99	810	690	120

Table: – 14 Qualitative abundance of plankton & benthos.

PHYTOPLANKTON	**b. Cladocera**
a. Cyanophyceae	*Bosmina*
Anabaena	*Moina*
Oscillatoria	*Ceriodaphnia*
Microcystis	*Diaphanosoma*
Chorococcus	*Scaphaloberis*
	Naupli
b. Chlorophyceae	
Spirogyra	**c. Copepoda**
Volvox	*Cyclops*
Chlorella	*Diaptomus*
Pediastrum	Naupli
Sphaerocystis	
Oedogonium	**BENTHOS:**
	a. Gastropoda
c. Bacillariophyceae	*Bellamya bengalensis*
Asterionella	*Thiara tuberculata*
Nitzschia	*Gyraulus convexiusculus*
Navicula	*Digniostoma cerameoboma*
ZOOPLANKTON	**b. Bivalvia**
a. Rotifers	*Lamellidens marginalis*
Brachionus	**c. Oligochaeta**
Keratella	*Tubifex* sp.
Filinia	*Branchiura sowerbyi*
Hexarthra	*Limnodrillus* sp.
Asplanchna	
Polyarthra	**d. Dipteran Insect**
	Chironomus sp.

Table: - 15 Species composition of major vertebrate groups.

Common Name	Scientific Name
FISH	
1. Rohu	1. *Labeo rohita*
2. Catla	2. *Catla catla*
3. Mrigal	3. *Cirrhinus mrigala*
4. Calbasu	4. *Labeo calbasu*
5. Pangus	5. *Labeo pangusia*
6. Singi	6. *Heteropneustes fossilis*
7. Magur	7. *Clarias batrachus*
8. Bele	8. *Glossogobius giuris*
9. Khalisa	9. *Trichogaster fasciatus*
10. Punti	10. *Puntius chrypsotera, P. ticto*
11. Chela	11. *Salmastoma bacaita*
12. Chanda	12. *Pseudoticobases nama*
13. Shrimp	13. *Macrobrachium lamarrei*
AMPHIBIA	
1. Kunobang	1. *Bufo melanostictus*
2. Sonabang	2. *Rana tigrina*
BIRD	
1. Great Cormorant	1. *Phalacracorax carbo*
2. Indian Shag	2. *P. furcicollis*
3. Little Cormorant	3. *P. niger*
4. Intermediate Egret	4. *Egretta intermediae*
5. Little Egret	5. *E. garzetta*
6. Common Kingfisher	6. *Alcedo hercules*
7. Black Headed Tern	7. *Larus ridibundus*

Table: - 16 Simple correlation between phytoplankton population and some physico - chemical variables of lake.

Water Variables	Correlation Coefficient (r)	Student t test (t)	Level of Significance (p)
Phytoplankton Vs.			
Water Temperature	0.71	3.152	>0.02
pH	0.66	2.781	>0.02
Dissolved Oxygen	0.19	0.612	NS
Total Alkalinity	0.69	3.097	>0.01
Total Nitrogen	0.56	2.148	>0.1
Total Phosphorus	0.58	2.563	>0.05
Ammonia Nitrogen	0.61	2.384	>0.05

NS = Not Significant.

Table: - 17 Macrophyte distribution of Subhas Sarobar Lake.

Scientific Name	Common Name	Habitat	Status ; Remark
EMERGENT AMPHIBIAN			
**Alternanthera philoxeroides*	Helencha	OW	Medium population; Economically used as vegetables.
**Enydra fluctuans*	Hingcha	WE	Largely found at the shoreline of the lake, leaf extract / whole plant used as a liver tonic.
Ipomoea aquatica	Kalmi	WE	Common plants of the lake, economically used as green vegetables.
Ludwigia adscendens	Kesaradam	WE/B/M	Medium population, they arise from the shore, gradually trail towards the open water and can float by means of their floating roots.
Cyperus platystylis	Tokapana	B/M	Common at the shore of small island.
C. rotundus	Tokapana	B/M	Common at the shore of small and large islands.
ANCHORED SUBMERGED			
**Vallisneria spiralis*	Patasheola	OW	Abundantly present in the open water of the lake, found upto 6-8 ft deep water. Used in aquarium.
FREE FLOATING			
Pistia stratiotes	Tokapana	OW	Very rare population, seasonally clear probably due to practice of pisciculture.
Lemna acquinoctiales	Khudipana	OW	Very few, reported first at the month of February.
Eichhornia crassipes	Kachuripana	OW	Common in all wetland cleared periodically due to practice of pisciculture.
FACULTATIVE IN WETLAND			
Heliotropium indicum	Hatisur	B/M	Common plants of wetland. Generally grow in moist places. Medicinal properties are reported by some author.
Eclipta alba	Kesuri/Kesuti	B/M	Common in moist places. Leaf decoction used as hair tonic.
Wedelia chinense	Bhringaraj	WE	Rarely found in the small island of the lake, used as hair tonic.
Oldenlandia corynbosa	Kesaradam	B/M	Very rare in this lake.
Centella asiatica	Thankuni	WE	Very few, leaf extract used as liver tonic.
Colocasia esculenta	Kachu	B/M	Medium population, thickened rootstocks of this plant are a source of starchy food.
Commelina benghalensis	Tokapana	B/M	Rarely found in the bank marsh.
Kyllinga brevifolia	Tokapana	B/M	Common in the shore of small and large islands

B/M = Bank / Marsh. OW = Open water. WE = Water edge. * = Abundant.

Temperature (^oC)

Sample no.	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.01.99	11.02.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	31	34	31	30	26	22	25	30	34	33.3	32.9	33.4	34.7
2	30.9	34	31	30	26	22	25	29.9	34	32.9	32.9	33.6	34.7
3	30.2	34	31	30	25	22	24.9	29	33.9	33.5	32.9	33.6	34.7
4	30.3	34	31	29.5	25	21	25.2	29.5	34	33.7	32.9	33.4	34.7
5	29.8	34	31	28	25.4	21.8	25	29	33.8	33.8	32.9	33.8	34.7
6	30	34	31	30	26	22	25	30	34.2	33.2	32.9	33.6	34.7
7	30.1	34	31	30	26	22	25	29	33.9	33.8	32.8	33.3	34.7
8	31	34	31	29.2	26	22	25	30	33.5	33.9	33	33.4	34.7
9	30	34	31	28	26	22	25.1	30	34	32.8	32.7	33.6	34.7

Turbidity (NTU)

Sample no.	27.8.98	16.9.98	21.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	7	10	10	11	11	9	11	10	10	10	10	10	11
2	8	8	7	10	10	11	7	11	10	11	11	15	13
3	10	8	10	9	8	12	9	11	8	9	10	12	11
4	8	7.5	9	11	7	11	6	8	11	8	9	15	25
5	7	8	9	7	10	10	6	9	7	10	8	16	22
6	8	8	7	8	10	7	9	10	8	9	7	14	13
7	10	6.5	8	8	7	11	6	11	11	9	10	13	16
8	10	8	10	11	10	10	6	10	9	9	12	13	12
9	12	8	7	11	12	8	5	9	10	12	11	14	14

P^H

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	8.15	8.5	8.25	7.56	7.10	7.58	8.55	7.0	8.25	8.81	8.80	9.50	10.15
2	8.16	8.7	8.16	7.52	7.20	7.46	8.45	7.1	8.30	8.72	8.75	9.0	10.15
3	8.25	8.8	8.15	7.62	7.11	7.42	8.15	7.1	7.68	8.0	7.8	8.9	9.55
4	8.09	8.9	8.75	7.70	7.32	7.50	8.70	7.0	7.56	8.35	8.65	9.3	10.35
5	8.10	8.8	8.79	7.75	7.45	7.22	8.70	7.0	8.51	8.68	8.70	9.2	10
6	8.29	8.6	8.58	7.65	7.18	7.31	8.10	7.0	8.46	8.36	8.55	9.1	10
7	8.29	8.7	8.72	7.84	7.58	7.48	8.47	6.5	8.85	8.67	8.57	9.2	10.05
8	8.27	8.4	8.41	7.91	7.24	7.23	8.72	7.0	7.39	8.79	8.91	9.4	10.15
9	8.28	8.9	8.92	7.68	7.36	7.14	8.25	7.0	7.52	8.73	8.85	8.5	9.75

Electrical conductivity (μS/cm)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	480.5	375.2	338.0	346	321.0	319	321	323	380	405	424	369	380
2	400.8	368.5	356.8	368	322.0	325	323	351	386	398	424	364	380
3	419.8	369.7	369.9	357	383.0	318	334	347	388	397	428	359	390
4	412.3	373.4	372.2	359	345.0	301	334	355	399	410	416	358	386
5	413.4	368.0	356.6	372	344.0	311	334	359	396	408	417	367	385
6	414.9	367.0	380.1	378	328.0	302	335	348	394	401	414	365	380
7	421.9	370.6	377.1	385	337.0	328	338	357	372	389	427	362	395
8	403.7	370.5	319.2	396	346.0	347	334	362	381	413	432	359	390
9	404.5	379.3	380.9	379	329.0	330	342	349	377	408	425	363	385

Total dissolved solids (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	340	212.9	302	218	270	310	310	312	342	365	387	301	288
2	348	212.7	340	225	260	320	318	336	346	362	386	304	287
3	346	212.7	336	230	250	308	326	327	357	358	390	299	303
4	351	213.5	294	215	240	236	327	348	372	356	395	296	305
5	369	211.0	326	247	200	267	326	350	378	369	388	294	310
6	372	213.9	336	226	220	283	330	303	387	362	358	287	301
7	353	209.2	267	229	223	292	334	337	361	361	395	305	335
8	342	216.3	330	257	245	286	328	351	355	359	405	301	310
9	345.0	209.2	332	210	227	279	315	342	347	358	410	298	300

Total solid (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	1130	1240	1148	820	1190	960	990	1132	1174	1168	1067	998	948
2	1080	1183	1075	935	1080	910	1003	1126	1217	1169	1060	995	1072
3	1125	1197	1132	1019	1050	918	1012	1116	1196	1159	1762	1006	984
4	1275	1142	1119	757	1070	811	1017	1173	1199	1158	1100	1009	986
5	1128	1232	1092	1035	1130	897	1004	1098	1222	1167	1108	999	989
6	1152	1159	1072	630	1140	943	1015	1026	1266	1165	1057	998	987
7	1147	1213	1026	749	1015	875	1031	1042	1206	1167	1123	994	1019
8	1138	1147	1152	763	1008	910	1012	1125	1178	1169	1100	1005	1008
9	1227	1139	1176	634	1100	872	1006	1094	1176	1175	1100	1007	984

Total suspended solid (mg/l)

Sampleno	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	790	1027.1	846	602	820	650	680	820	832	812	680	697	658
2	732	970.3	735	710	820	590	685	790	871	807	675	691	681
3	779	984.3	796	789	800	610	686	789	839	801	686	707	785
4	924	928.5	825	542	830	575	690	825	827	802	705	713	681
5	759	1021	766	788	930	630	678	748	844	798	720	705	679
6	780	945.8	736	404	920	660	685	723	879	803	699	711	686
7	794	1003.8	759	520	792	583	697	705	845	806	728	689	684
8	796	930.7	822	506	763	624	684	774	823	810	695	704	698
9	882	929.8	844	424	873	593	691	752	829	817	690	709	684

Total Alkalinity (mg/l)

Sampleno	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	99.9	130	130	102	100	120	99	139	110	125	135	144	150
2	101.2	147.5	125	107	106	115	132	119	120	128	160	147	142
3	130.4	125.6	126	96	107	117	128	109	117	129	212	148	130
4	107.2	131.1	141	98	103	149	127	109	113	130	158	142	176
5	104.5	137.9	129	106	105	127	134	114	111	131	144	150	145
6	109.8	142.5	136	108	100	135	116	110	109	128	171	149	145
7	102.6	146.8	147	98	106	123	120	110	115	125	150	141	130
8	105.8	130.5	152	107	110	117	125	108	125	132	146	142	150
9	110.9	134.2	110	105	94	132	123	106	136	129	152	146	156

Dissolved oxygen (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	5.6	5.8	5.2	4.8	5.7	7.2	6.2	6.8	6.3	9.6	8.6	9.8	7.6
2	5.7	5.2	5.1	4.5	7.4	7.2	6.8	6.0	6.4	9.9	7.8	9.5	7.2
3	4.2	6.1	5.7	3.9	4.5	7.4	5.9	6.8	4.2	10	7.4	9.2	6.4
4	5.9	6.8	6.2	4.5	7.0	6.8	7.2	7.2	5.6	9.9	8.4	8.9	5.6
5	4.7	5.1	5.8	4.2	6.0	7.6	6.6	6.8	3.1	8.6	9.2	8.8	6.2
6	4.6	5.7	6.1	5.0	6.0	5.4	6.5	7.0	4.8	9.7	8.6	8.7	7.2
7	4.6	5.6	6.7	4.6	6.2	6.8	4.9	6.9	5.8	9.8	7.6	9.2	6.6
8	4.8	5.1	5.4	5.1	5.9	7.2	5.8	7.3	6.3	9.9	8.2	9.1	7.3
9	5.7	5.8	5.1	5.2	6.1	6.9	6.2	5.8	6.5	9.2	7.8	9.6	6.8

Biochemical oxygen demand (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	10.5	11.5	12.0	10.0	11.5	10.5	5.5	4.0	15.0	10.0	6.60	6.8	6.90
2	12.5	12.0	14.0	12.0	15.5	12.5	7.0	6.0	18.0	15.0	4.80	7.8	6.90
3	10.0	9.0	16.0	9.0	10.5	6.5	5.0	8.5	20.0	15.0	7.80	7.2	8.60
4	15.5	14.0	15.0	14.0	16.5	7.0	18.0	8.0	21.0	12.0	6.80	7.5	7.70
5	12.0	13.5	13.0	15.0	14.5	7.5	3.0	9.0	17.0	11.5	7.40	6.4	6.90
6	10.0	10.5	12.0	16.0	18	8.0	4.0	8.0	19.0	10.0	6.40	8.1	10.30
7	14.0	15.0	11.5	13.0	15	7.5	4.5	7.5	18.0	15.0	6.80	7.9	8.60
8	14.5	13.0	14.5	12.0	14.5	12.0	6.0	9.5	21.0	12.0	7.40	7.6	7.80
9	13.0	14.5	12.0	14.0	18	8.5	3.0	4.0	20.0	12.0	8.20	8.2	8.80

Chemical oxygen demand (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	140	180	155	100	80	130	156	130	144	130	100	100	80
2	150	172	126	140	70	100	119	110	84	128	120	108	90
3	130	178	138	130	90	60	147	160	158	125	130	109	100
4	100	135	132	144	100	100	73	60	92	132	80	98	95
5	120	205	148	135	70	90	128	100	120	134	90	100	80
6	110	162	135	100	100	80	138	120	100	132	100	107	115
7	140	160	147	125	60	95	130	121	160	128	90	105	100
8	130	155	152	135	75	100	137	119	128	127	120	103	90
9	120	153	141	142	80	70	115	132	130	122	140	104	100

Total hardness (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	52	52	52	75	70	52	51	69	43	47	72	71	70
2	61	55	53	38	81	55	54	76	55	48	78	68	67
3	61	52	52	32	62	46	49	60	68	47	63	63	61
4	57	52	52	41	46	42	37	76	67	46	64	65	57
5	52	57	51	51	48	66	61	75	51	50	69	72	68
6	52	52	55	55	66	47	33	79	62	51	75	75	59
7	55	52	54	53	72	50	50	76	47	47	71	60	58
8	53	53	52	52	82	56	58	74	59	44	70	78	69
9	52	58	55	54	65	48	52	68	75	43	68	71	67

Surfactant (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.14	0.00	0.23	0.04	0.03	0.02	0.16	0.42	0.23	0.25	0.16	0.23	0.36
2	0.00	0.08	0.08	0.11	0.07	0.06	0.04	0.75	0.08	0.10	0.12	0.12	0.09
3	0.35	0.08	0.08	0.06	0.05	0.06	0.36	0.08	0.08	0.07	0.10	0.15	0.08
4	0.00	0.18	0.10	0.07	0.02	0.01	0.10	0.08	0.08	0.06	0.10	0.06	0.08
5	0.40	0.46	0.00	0.02	0.03	0.01	0.24	0.09	0.73	0.59	0.42	0.54	0.35
6	0.10	0.15	0.13	0.11	0.06	0.04	0.07	1.18	1.15	1.08	0.96	1.10	0.81
7	0.08	0.09	0.08	0.00	0.00	0.10	0.06	0.56	0.47	0.62	0.39	0.26	0.38
8	0.09	1.05	0.00	0.00	0.00	0.10	0.00	0.09	0.08	0.04	0.10	0.08	0.05
9	0.10	0.09	0.01	0.02	0.01	0.03	0.00	0.65	0.51	0.47	0.25	0.49	0.19

Total nitrogen (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	4	6.2	4.4	4.0	2.8	2.0	1.5	1.7	1.5	0.9	1.5	1.4	16.2
2	4.6	6.8	5.6	5.8	3.5	3.1	1.3	0.4	0.9	0.8	1.8	1.3	20.2
3	5.6	4.1	3.9	5.6	3.2	2.5	0.7	0.8	0.9	1.2	0.9	1.7	15.8
4	5.1	5.9	4.6	4.7	2.1	1.6	0.9	1.7	1.8	0.9	1.6	1.2	24.6
5	4.7	4.7	4.3	3.1	1.3	1.0	1.0	3.5	1.5	1.3	1.3	1.9	29.5
6	3.8	6.5	4.7	4.5	2.3	1.3	1.0	5.2	3.2	0.8	2.2	1.6	20.2
7	4.8	4.0	5.9	4.2	1.5	1.0	1.2	0.9	1.1	0.9	1.9	1.2	16.4
8	5.7	3.8	4.1	3.9	2.3	2.8	0.2	1.3	2.3	1.3	1.7	0.7	24.8
9	4.3	7.2	3.5	3.8	1.9	1.9	0.9	1.5	0.6	0.9	1.5	0.5	26.4

Ammonia nitrogen (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	1.36	2.35	0.27	0.20	0.48	0.25	0.20	0.30	0.67	0.16	0.31	0.17	1.4
2	0.68	2.68	0.40	0.08	0.52	0.19	0.27	0.35	0.35	0.14	0.25	0.24	1.63
3	0.65	0.42	0.17	0.17	0.39	0.32	0.00	0.30	0.31	0.09	0.28	0.25	1.11
4	0.56	1.19	0.29	0.30	0.28	0.21	0.20	0.55	0.73	0.13	0.28	0.09	1.71
5	0.67	0.31	0.26	0.13	0.26	0.23	0.00	0.30	0.23	0.12	0.36	0.14	1.82
6	1.18	1.73	0.28	0.29	0.35	0.13	0.00	1.88	0.92	0.05	0.41	0.06	1.66
7	1.25	0.21	0.85	0.20	0.40	0.21	0.10	0.30	0.87	0.46	0.18	0.19	1.54
8	0.61	0.12	0.38	0.31	0.32	0.20	0.00	0.50	1.01	0.35	0.56	0.18	1.83
9	0.51	1.87	0.27	0.18	0.21	0.24	0.20	0.32	0.22	0.38	0.19	0.25	1.88

Nitrate nitrogen (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.59	0.62	0.75	0.17	0.40	0.62	0.09	0.05	0.49	0.28	0.27	0.35	0.98
2	0.41	1.03	1.0	0.18	0.11	0.43	0.16	0.12	0.80	0.22	0.12	0.42	1.00
3	1.09	0.58	0.63	0.16	0.18	2.02	0.29	0.27	0.27	0.35	0.11	0.21	2.30
4	2.42	0.49	0.41	0.28	0.08	0.41	0.08	0.05	0.38	0.36	0.25	0.38	0.86
5	0.89	0.72	0.39	0.15	0.06	0.32	0.07	0.28	0.12	0.41	0.15	0.35	0.72
6	1.0	0.35	0.28	0.16	0.13	1.02	0.14	0.30	0.19	0.19	0.22	0.42	0.95
7	0.62	0.28	0.71	0.19	0.13	0.60	0.14	0.23	0.30	0.20	0.20	0.46	0.98
8	0.84	0.41	0.68	0.23	0.09	0.84	0.08	0.09	0.38	0.22	0.24	0.32	1.10
9	0.68	1.0	0.53	0.24	0.08	0.51	0.09	0.15	0.29	0.23	0.18	0.28	0.89

Total phosphorus (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	1.55	1.87	1.35	1.22	0.56	1.01	1.29	3.0	1.31	1.35	0.75	3.37	0.18
2	1.68	1.92	1.22	1.38	0.62	1.12	0.95	3.2	0.81	1.42	1.05	1.35	0.34
3	1.58	0.75	1.17	1.75	0.49	0.58	0.06	1.8	0.52	1.29	1.68	1.25	0.20
4	1.89	0.79	0.98	1.17	0.61	0.47	0.54	1.6	1.01	1.02	1.10	2.25	0.24
5	2.06	0.49	1.03	1.62	0.72	0.36	0.71	3.6	0.93	1.08	1.08	1.00	0.19
6	1.92	1.13	1.09	1.49	0.41	0.42	0.03	3.0	2.12	1.31	1.51	1.25	0.22
7	1.46	0.36	1.18	1.32	0.49	0.32	0.82	3.0	0.78	1.09	1.05	0.62	0.35
8	1.75	0.28	1.05	1.47	0.53	0.41	0.95	2.6	0.84	1.18	1.06	2.25	0.37
9	1.15	1.48	0.71	1.21	0.61	1.18	1.12	2.2	0.50	1.19	1.29	1.75	0.28

Inorganic phosphorus as phosphate (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.31	0.48	0.31	0.61	0.30	0.35	0.33	0.52	0.62	0.65	0.66	0.38	0.18
2	0.52	0.59	0.65	0.45	0.32	0.22	0.13	1.48	0.74	0.62	0.75	0.52	0.34
3	0.49	0.25	0.17	0.48	0.28	0.38	0.26	1.50	0.44	0.59	0.38	0.69	0.20
4	0.47	0.38	0.25	0.53	0.34	0.23	0.17	1.61	0.50	0.52	0.56	0.72	0.24
5	0.45	0.32	0.24	0.51	0.33	0.25	0.24	2.30	0.27	0.61	0.79	0.57	0.19
6	0.75	0.46	0.31	0.55	0.16	0.24	0.21	1.30	0.37	0.71	0.19	0.31	0.22
7	0.71	0.35	0.68	0.43	0.32	0.24	0.24	1.02	0.38	0.62	0.42	0.32	0.35
8	0.76	0.19	0.38	0.38	0.28	0.36	0.28	1.14	0.35	0.64	0.59	0.35	0.37
9	0.15	0.51	0.22	0.52	0.25	0.21	0.31	1.21	0.23	0.60	0.35	0.24	0.28

Total sulphur as sulphate (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	7.05	8.25	7.05	7.36	7.35	7.31	15.6	7.31	7.17	7.82	9.21	7.12	14.9
2	9.39	9.54	9.39	8.87	7.04	8.15	18.2	7.29	8.38	7.69	9.38	7.81	15.1
3	2.90	7.37	2.90	7.34	8.21	7.54	17.7	7.36	6.24	6.41	8.76	6.34	10.5
4	8.07	7.15	8.07	7.34	6.36	7.22	18.5	7.42	0.00	6.32	8.52	5.42	10.5
5	6.17	6.89	6.17	7.82	7.34	7.38	17.3	7.51	7.40	6.14	7.38	7.28	10.9
6	7.25	7.23	7.32	7.35	7.48	7.47	21.2	7.36	12.0	7.83	9.50	7.31	13.8
7	7.89	6.47	7.09	7.31	7.45	7.62	15.2	7.75	8.35	7.19	9.08	7.45	12.9
8	5.38	4.24	7.52	7.42	7.81	7.51	17.5	7.78	7.24	7.38	8.75	7.24	16.2
9	6.12	6.85	7.38	7.79	7.02	7.78	11.8	7.89	7.92	7.84	6.29	7.12	15.6

Potassium (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	6.31	7.88	6.46	9.84	5.94	5.14	3.49	5.14	6.45	7.16	6.92	8.36	9.35
2	5.82	6.48	7.81	9.52	6.40	5.26	5.46	5.26	5.17	7.25	7.17	8.92	9.36
3	7.32	5.37	6.93	9.65	6.68	6.99	2.15	6.37	6.20	6.89	6.26	9.35	8.72
4	4.97	5.42	8.86	7.86	4.97	7.05	3.86	6.41	6.27	6.95	6.89	9.89	8.85
5	6.41	6.71	7.37	6.31	3.07	4.28	4.02	5.19	6.76	5.32	7.31	8.76	8.72
6	5.39	5.48	8.49	4.28	4.86	4.54	5.00	6.50	6.29	6.81	5.82	8.82	8.75
7	6.39	5.49	9.36	9.37	5.71	7.36	6.37	5.38	5.38	7.06	6.97	8.87	9.36
8	7.28	6.42	7.55	8.86	5.86	6.91	5.82	5.62	4.25	6.32	6.25	8.96	10.25
9	6.42	6.86	7.68	8.75	6.18	7.09	5.91	5.47	7.01	6.96	6.95	8.76	9.85

Iron (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.05	0.08	0.09	0.08	0.04	0.04	0.01	0.01	0.01	0.01	0.01	0.00	0.00
2	0.09	0.09	0.08	0.05	0.01	0.02	0.01	0.03	0.00	0.02	0.03	0.01	0.01
3	0.12	0.05	0.05	0.06	0.06	0.00	0.00	0.02	0.03	0.00	0.01	0.02	0.04
4	0.08	0.07	0.09	0.07	0.01	0.01	0.02	0.04	0.02	0.00	0.00	0.02	0.00
5	0.08	0.08	0.06	0.08	0.05	0.05	0.03	0.03	0.25	0.03	0.01	0.01	0.05
6	0.03	0.05	0.04	0.07	0.03	0.05	0.06	0.02	0.01	0.06	0.01	0.03	0.03
7	1.07	0.05	0.12	0.06	0.04	0.04	0.05	0.02	0.02	0.00	0.02	0.00	0.03
8	0.09	0.04	0.09	0.08	0.08	0.03	0.04	0.03	0.00	0.01	0.03	0.00	0.02
9	0.11	0.06	0.11	0.09	0.09	0.06	0.01	0.01	0.03	0.01	0.00	0.02	0.00

Lead (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	BDL	B.D.L	B.D.L	0.099	B.D.L	BDL	0.069	B.D.L	0.01	BDL	BDL	0.05	BDL
2	0.01	B.D.L	B.D.L	0.051	0.038	BDL	0.07	0.07	B.D.L	BDL	BDL	BDL	BDL
3	BDL	0.091	B.D.L	0.095	0.087	BDL	BDL	0.06	B.D.L	BDL	BDL	BDL	0.01
4	BDL	0.091	0.038	B.D.L	B.D.L	BDL	0.01	0.08	B.D.L	0.01	BDL	0.23	0.01
5	BDL	0.071	B.D.L	B.D.L	0.075	0.091	0.05	0.07	B.D.L	BDL	BDL	0.20	0.01
6	0.01	B.D.L	0.083	0.073	B.D.L	BDL	0.06	0.09	0.01	0.01	BDL	BDL	0.04
7	0.02	B.D.L	B.D.L	B.D.L	B.D.L	BDL	0.03	BDL	B.D.L	BDL	BDL	BDL	BDL
8	BDL	B.D.L	B.D.L	B.D.L	B.D.L	BDL	BDL	0.01	0.01	BDL	BDL	0.01	BDL
9	B.D.L	B.D.L	B.D.L	0.089	B.D.L	BDL	B.D.L	B.D.L	B.D.L	BDL	BDL	BDL	0.02

Zinc (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.01	0.00	0.00	0.02	0.01	0.00	0.00	0.04	0.04	0.07	0.00	0.01	0.06
2	0.02	0.00	0.00	0.00	0.02	0.01	0.01	0.09	0.01	0.04	0.01	0.01	0.07
3	0.00	0.01	0.03	0.01	0.01	0.04	0.01	0.02	0.02	0.01	0.01	0.00	0.00
4	0.04	0.07	0.00	0.03	0.00	0.03	0.02	0.00	0.00	0.05	0.01	0.04	0.05
5	0.06	0.00	0.09	0.00	0.01	0.02	0.00	0.00	0.02	0.20	0.00	0.02	0.03
6	0.00	0.05	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.01
7	0.00	0.00	0.00	0.01	0.00	0.02	0.03	0.00	0.02	0.03	0.00	0.03	0.01
8	0.00	0.08	0.01	0.02	0.03	0.00	0.00	0.00	0.06	0.04	0.01	0.01	0.01
9	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.00	0.00

Mercury (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
2	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
3	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
4	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
5	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
6	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
7	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
8	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.
9	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.

Chromium-Total (mg/l)

Sample no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.00	0.00	0.00	0.00	0.00	0.00	0.005	0.00	0.00	0.00	0.00	0.01	0.00
2	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01
3	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01
4	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
8	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
9	0.01	0.00	0.00	0.00	0.00	0.00	0.001	0.00	0.00	0.01	0.01	0.00	0.00

Cadmium-Total (mg/l)

Sampl e no	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.04	0.04	0.03	0.00	0.07	0.06
2	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.09	0.01	0.00	0.01	0.00	0.07
3	0.00	0.00	0.00	0.01	0.01	0.04	0.01	0.02	0.02	0.07	0.01	0.00	0.00
4	0.00	0.00	0.00	0.03	0.00	0.03	0.02	0.00	0.00	0.01	0.01	0.04	0.05
5	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.02	0.00	0.00	0.01	0.03
6	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.01
7	0.00	0.00	0.00	0.01	0.00	0.02	0.03	0.00	0.02	0.00	0.00	0.00	0.01
8	0.00	0.00	0.01	0.02	0.03	0.00	0.00	0.00	0.06	0.00	0.01	0.00	0.01
9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.01	0.00	0.00

SEDIMENT

pH

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	6.7	6.3	6.0	7.5	7.3	6.1	6.0	6.5	7.1	7.0	6.1	6.0	6.7
2	6.2	6.1	6.3	7.6	7.2	6.8	6.7	6.3	6.5	6.9	6.3	6.1	6.1
3	6.5	6.2	6.2	7.5	7.1	7.0	6.4	5.4	6.0	6.5	6.1	6.0	6.2

Electrical Conductivity (µs/cm)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	410	390	415	420	416	411	415	385	414	435	386	424	405
2	422	425	438	416	407	403	415	407	416	428	395	428	418
3	415	430	427	432	410	415	415	398	410	437	398	425	421

Organic Carbon (%)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	1.19	1.19	1.19	1.14	1.27	1.13	1.32	1.41	1.23	1.24	1.23	1.98	1.15
2	1.13	1.21	1.16	1.12	1.31	1.21	2.19	1.92	1.05	1.36	1.28	2.35	1.19
3	1.12	1.19	1.25	1.22	1.24	1.19	2.29	2.15	1.78	1.08	1.13	1.82	1.26

Total Nitrogen (mg/kg)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.52	0.37	0.57	0.37	0.82	0.54	0.61	0.71	0.34	0.58	0.62	0.45	0.68
2	0.63	0.37	0.31	0.25	0.65	0.71	0.59	0.65	0.84	0.62	0.81	0.82	0.54
3	0.59	0.29	0.38	0.34	0.68	0.56	0.64	0.31	1.31	0.51	1.02	0.83	0.67

Total Phosphorous (mg/kg)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.19	0.21	0.28	0.32	0.24	0.23	0.28	0.19	0.13	0.29	0.15	0.19	0.23
2	0.23	0.21	0.20	0.20	0.33	0.47	0.21	0.12	0.15	0.20	0.21	0.18	0.14
3	0.14	0.19	0.32	0.21	0.28	0.31	0.19	0.04	0.12	0.18	0.18	0.17	0.19

Lead (mg/l)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	0.41	1.4	0.39	0.56	0.23	0.42	BDL	0.03	0.29	0.25	0.83	0.38	0.51
2	0.38	1.2	0.47	0.47	0.36	0.34	BDL	0.01	0.15	0.15	0.95	0.46	0.42
3	0.32	1.6	0.42	0.53	0.41	0.29	BDL	0.01	0.30	0.19	1.25	0.48	0.61

Mercury (mg/l)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Cadmium (mg/l)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Chromium (mg/l)

Sample site	27.8.98	16.9.98	26.10.98	19.11.98	17.12.98	14.1.99	11.2.99	17.3.99	22.4.99	25.5.99	29.6.99	29.7.99	19.8.99
1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Pollution status of Subhas Sarobar

Studies on Subhas Sarobar through out the season revealed the following clues giving rise to an adverse effect on the ecology of the ecosystem.

Total suspended solids are well above the threshold limit and restricts the penetration of sunlight only within three meters, the photic zone depth.

The dissolved oxygen content in surface water are under-saturated during most of the time of the year and thus, can not serve as potential source of pure oxygen supply to the environment.

The appearance of an important physical event, thermal stratification during February to November, separates the water body into two distinct layers of epilimnion (lower dense strata) and hypolimnion (higher dense strata) with different physico-chemical characteristics. With the shift from an aerobic to an-aerobic hypolimnion, a large, often major volume of water is excluded from habitation by most animals and many plants. Another major change is the shift from aerobic to anaerobic bacterial metabolism which markedly reduces overall efficiency of decomposition of organic matter, gradually increasing the load of dissolved organic matter in the system.

The ratio of BOD to COD is very low implying the presence of large amount of undegraded organic matter of refractory origin which imparts unusual color in water and restricts the penetration of sunlight and provides to prolifirate specific unusual biotic composition in the medium.

N/P ratio in the present study is lower than that used by plankton, indicating comparatively higher amount of phosphorus in the medium. This enrichment of phosphorus encourage to dominate nitrogen fixing algae to balance the nutrient ratio. The occurrence of Cyanophyceae at about 68 % of total population through out the year along with genera of Microsystis, Anabaena, Chorcoccus and Oscillatoria are indicative of organic pollution and eutrophic condition in the medium.

Similarly the presence of dominating group of Rotifera (86%) among the fauna together with genera Brachionus, Keratella, Fillinia and Polyarthra, also support the existence of organic pollution and eutrophication in the medium.

The population density of benthic organism, dominated by gastropod mollusc only, decreased from littoral zone to limnetic zone and were completely absent beyond 3.4 m depth. This collaborated with the previous findings that above this depth due to presence of unhygienic condition it is very difficult for the animals to survive.

Considering total average depth in Subhas Sarobar as 12 m it can be inferred that about 65 % of total volume of water is unsuitable for the occurrence of common plants and animals through out the year, may be due to the presence of toxic gases of H_2S at low pH and anoxic condition in the lower strata.

The levels of trace metals are very low in surface water and almost absent in sediments excepting with only Pb of below 1.0 ppm level. Since sediments are recognised as trapping area of suspended and detritus matter from the overlying water, hence deposition must be taking place but the anoxic condition prevailing at the sediment-water interface with lower pH of the soil-suspension, encourage the mobilisation of associated trace metals to the large volume of overlying water bringing about significant dilution. This phenomena prevents the metals from enrichment in the sediments. Thus, Subhas Sarobar is seemed to be free from trace metal pollution in water as well as in the sediments.