Upgradation and Management of Rabindra Sarobar Lake in Kolkata

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ABSTRACT

The inland freshwater ecosystems contribute a considerable fraction towards the available water resource which is now being increasingly subjected to greater stress from various human activities. Degradation of wetlands is very common due to discharges of liquid effluents, disposal of solid waste and localized human population in the surrounding and their activities. Almost seventy five years ago, the marshy jungle in southern part of Kolkata city - the breeding ground of mosquitoes–was converted to a major environmental reserve, known as 'Rabindra Sorobar', without compromising the basic natural character of the land. The importance of the lake (Rabindra Sorobar) for ecological balancing was felt by the South Kolkata citizens who always stressed on the need for safeguarding the lake from any deterioration. But slowly the lake was found to be a victim of unplanned and uncared development of Kolkata, including unconcerned behavior of certain people residing in the surroundings of the lake. The lake water quality deteriorated due to discharge of sewage and sullage, disposal of solid waste, uncontrolled bathing and washings etc. resulting in severe eutrophication of the lake.

In order to save Rabindra Sarobar Lake from ecological damage, the squatters / slum dwellers were shifted from the surrounding locality and also all point sources of pollution were diverted to the municipal sewerage system. All water hyacinths were removed from the lake. Water quality monitoring results during January and April 2007 revealed dissolved oxygen level between 6.0 and 8.0 mg/l and average ammonia-nitrogen in the lake was found to be at lower side (0.16 mg/l). The faecal coliform in the lake was found in the range between 24 and 2800 per 100ml.The Rabindra Sorobar Lake was classified as class 'D' as per water quality status. Heavy metals (zinc, cadmium, copper, lead and chromium) depositions due to disposal of solid waste, immersion of idols etc. were detected in sedimentary deposits of the lake.

Environment Management Plan for the lake was suggested which included solid

waste management, banning of plastic, manual removal of water hyacinths, drainage improvement etc. People participation for the maintenance of the lake was also suggested.

INTRODUCTION

The Rabindra Sarobar (RS) or the Dhakuria Lake (22'34'N, 88'23'E) as it is known locally (Fig. 1) represents the lung of vast regions of the southern part of the city of Kolkata. It was excavated during the first quarter of the last Century by the Kolkata (erstwhile Calcutta) Improvement Trust as a part of urban development. The Dhakuria Lake complex is located in the southern part of the metropolis of Kolkata spread over an area of 780,700 m^2 having water body of 295,400 m^2 (or about 38 % of the land area). There are four water-bodies with different morphometry and denoted by basin -K, L, M and N (as illustrated in Fig. 1) for convenience. The larger waterbody, i.e. basin -K has water area of about 171,000 (m^2) and contains three small islands within it. The next big water body is the basin -N having water area of 66,400 (m^2) and contains one island within it (Fig: 2). These two basins in the Rabindra Sarobar are connected by a small channel of length 20 m and width 15 m with a mean water depth of 0.6 m. This channel is covered with water hyacinths and other small plants round the year over which there is a bridge for connecting the intercity roads.

SITE SIGNIFICANCE

Environmental

Rabindra Sarobar is one of a few green open-spaces that are still somehow sustaining the otherwise over crowded city and is valued treasure to the citizens.It is a significant environmental resource and an important bio-reserve of Kolkata in general, and South Kolkata, in particular. It is popularly known as the 'Lungs of South Calcutta'. Till a few years ago, migratory birds used to flock the lake, but have become irregular due to the rising pollution level and over-crowding.

HISTORICAL

The mosque in one of the islands predates the excavation of the lake. It is connected with the mainland with a cable-suspended bridge, erected in 1926.Some cannons found during excavation have been retained on the southern bank of the lake and are believed to have been used by Nawab Siraj-ud daula, the last independent ruler of Bengal before Lord Clive took over.In addition to these, the bungalow of one Mr. Anderson was also said to be existed before the formation of the lake that later came to be known as Anderson Club- one of the oldest swimming clubs (now Indian Life Saving Society).

WATER QUALITY MONITORING

Water samples were collected from different locations of the lake as mentioned in Fig.3 for determining chemical and bacteriological quality of lake water.

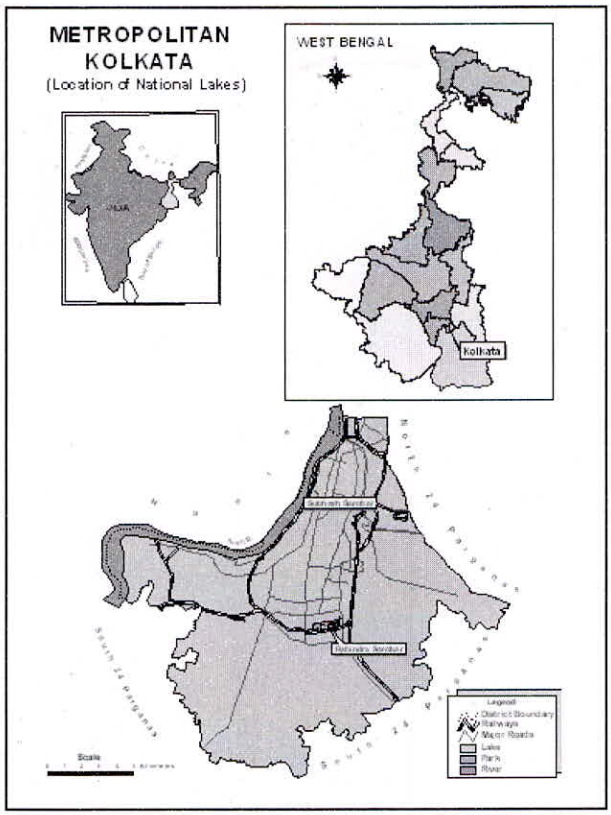

Fig. 1 (a): Location of National Lakes in Metropoliton Kolkata (Samal, 2005)

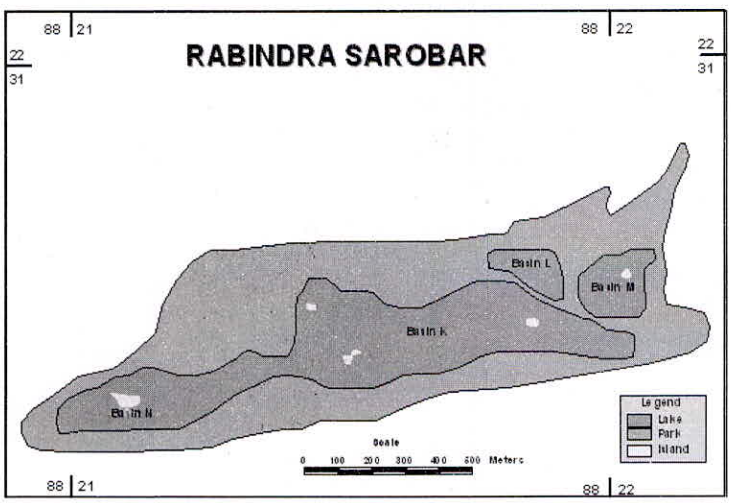

Fig. 1 (b) : Schematic diagram of the Rabindra Sarobar (Samal, 2005)

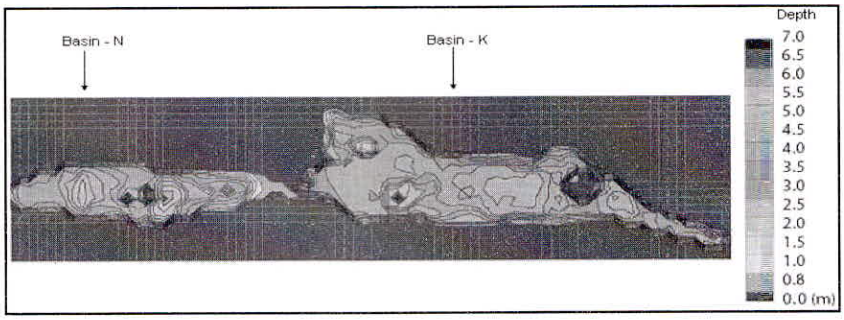

Fig. 2: Basin-wise Bathymetric map for basin K and N of Rabindra Sarobar (Samal, 2005)

Present Status of the Sarobar

Table: 1 Limnological characteristics of Rabindra Sarobar

	Limnological characteristics	Unit	Rabindra Sarobar	
			Basin-K	Basin-N
1	Latitude		220 34' N	
2	Longitude		880 23' E	
3	Lake altitude (a.m.s.l)	(m)	6.0	6.0
4	Lake complex area (LCA)	(× 104 m2)	78.07	
5	Lake water area (A)	(× 104 m2)	17.1	6.64
6	Lake water area/Lake complex area	(× 104 m2)	0.22	0.08
7	Total Lake area (At)	(× 104 m2)	17.68	6.73
8	Lake water volume (V)	(× 103 m3)	532.2	207.6
9	Maximum length (Lmax)	(m)	1085	643
10	Maximum effective length (Le)	(m)	379.2	304.8
11	Mean length (L)	(m)	1082	642
12	Effective length (LS)	(m)	396	297.6
13	Fetch area (Farea = Area1/2)	(× 102 m2)	4.1	2.6
14	Effective fetch (Feff)	(m)	261.6	223.4
15	Maximum width (Bmax)	(m)	269	149
16	Maximum effective width (Be)	(m)	144	142
17	Mean width (B)	(m)	184	102
18	Maximum depth (Zmax)	(m)	5.7	6.5
19	Mean depth (Zmean)	(m)	3.5	3.6
20	Relative depth (Dr) (%)		1.2	2.2
21	Shoreline length (lo)	(m)	2642.4	1426
22	Total shoreline length (lt)	(m)	3280.8	1584.4
23	Shoreline development (DL)		1.7	1.5
24	Volume development (Vd)		1.8	1.6
25	Insulosity (In) (%)		3.3	1.3
26	Maximum Secchi-Depth	(m)	1.50	1.46

A good number of water sampling stations (28 numbers) were selected in the lake for analysis of chemical and bacteriological quality.

The average BOD (5 day, 20°C) of the lake water has been found to be 5.13 mg/l (ranging from 2 mg/l to 9 mg/l). As sewage/ sullage are not getting discharged in the lake

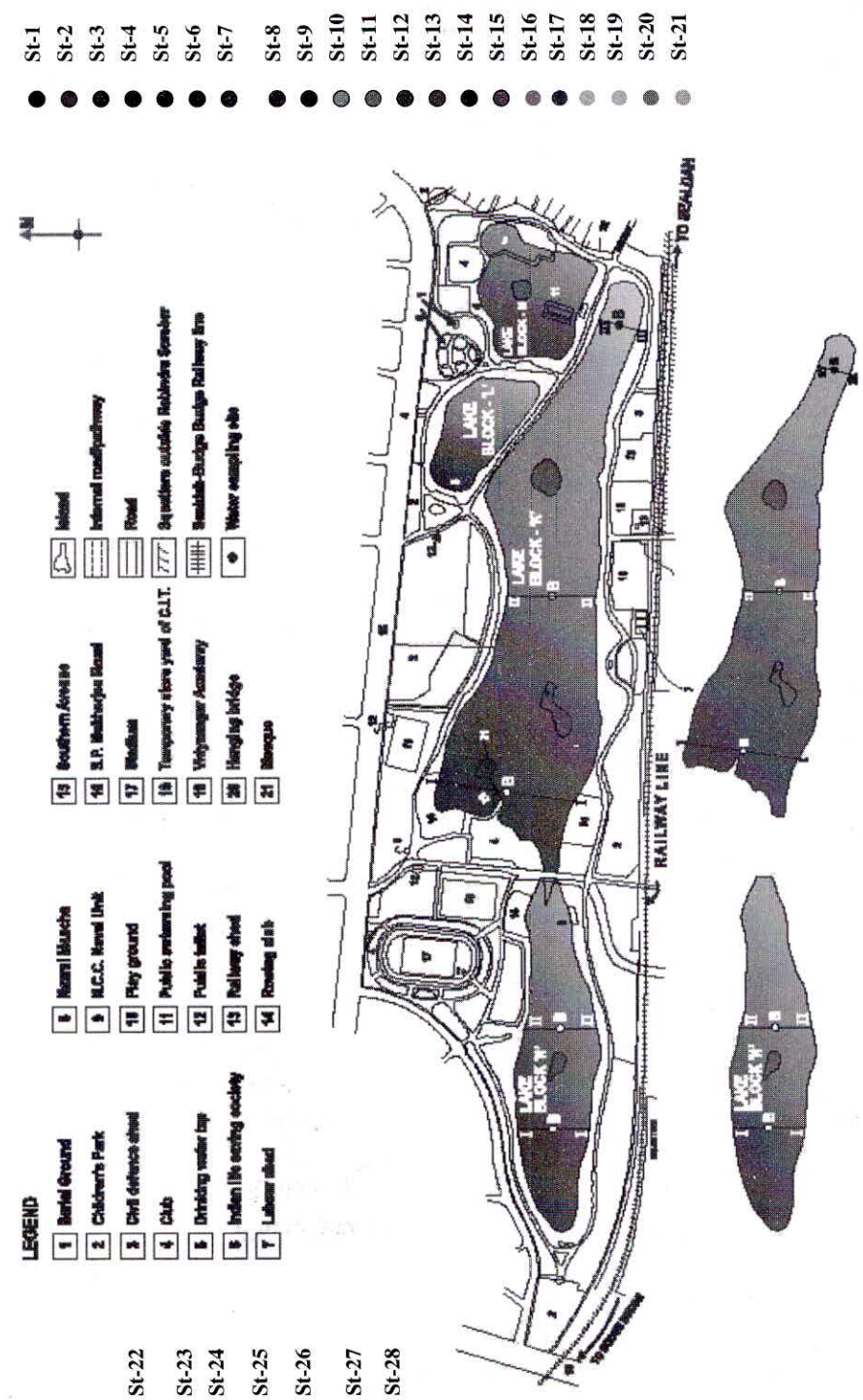

Fig: 3 Details of lake sampling Station in Rabindra Sarobar

(this has been verified during site survey), the contribution of organic load in the lake could be from residue of aquatic plants and solid wastes. It is expected that BOD of the lake water will get reduced in future after taking lake management plan (Table 3 & 4).

The average PH values of the lake water are found to vary from 7.44 to 8.07. The PH of the lake water is remaining slightly in alkaline range which also substantiates the growth of algae in the lake. The algal growth is not very high as the BOD of the lake water ranged between 2 to 9 mg/l. The algae in the lake are growing due to photosynthesis to maintain symbiotic relation with bacteria. (Table 3 & 4)

Table 2: Chemical quality of Rabindra Sarobar (January, 2007)

Sample Name	Depth	DO mg/l	BOD mg/l	COD mg/l	Chloride mg/l	Phosphorus as (P) mg/l	p^H	TDS mg/l	Ammoniacal Nitrogen (N)mg/l
ST-1	6 in	9.8	3.5	15.4	112.59	0.18	7.438	249	0.13
	1 m	9.6							
	3.7 m	8.0							
ST-2	6 in	9.9	9	23.1	93.18	0.12	7.474	235	0.17
	1 m	8.1							
	3.7 m	7.4							
ST-3	6 in	9.6	6.5	32	115.5	0.10	7.971	229	0.16
	1 m	8.8							
	3.7 m	8.2							
ST-4	6 in	9.3	5.4	40	128.12	0.11	7.567	241	0.18
	1 m	8.4							
	3.7 m	7.4							

The average DO (Dissolved Oxygen) level in the lake ranged between 6 to 8 mg/l at average temperature of 22° C. Hence oxygen saturation level of 67% to 88% is maintained in the pond. A favorable bio-environment for fish is maintained in the pond at present (Table 3 & 4).

The average total dissolved solids in the lake have been estimated to be 230 mg/l. The average chloride concentration in the lake remains to be 101.73 mg/l (Table 5). This indicates that ground water infiltration is minimum. The lake water maintains a typical property of surface water body.

The average Ammoniacal Nitrogen (as N) in the lake water has been found to be 0.16 mg/l which is comparatively remaining at lower level. This indicates that the lake water is not polluted with sewage. Higher Ammoniacal Nitrogen may cause deleterious effect in the pond with the risk of fish kill during day time. The Phosphorous (as P) in the lake water has been estimated to be 0.115 mg/l (Table 5).

The bacteriological analysis was conducted in the laboratory to access total coliform and faecal coliform .Samples were collected from 10 locations during February 2007.The Total Coliform (MPN count) was varied between 5000 to 350 per 100 ml . In the above locations, the Faecal Coliform (MPN count) was varied between 2800 and 24 MPN per

Table 3: Chemical quality of Rabindra Sarobar (January, 2007)

Sample Name	Depth	DO mg/l	BOD mg/l	COD mg/l	Turbidity NTU	Chloride mg/l	Phosphate mg/l	p^H	TDS mg/l	Temp. 0C	Conductivity µs	Ammoniacal Nitrogen (N) mg/l
ST-11	6 in	7.4	5	16	2	147.53	0.10	8.048	259	22.3	442	0.16
	1 m	7.7										
	3.75 m											
ST-12	6 in	8.0	5	18	1	98.03	0.10	7.940	215	22.2	377	0.18
	1 m	7.9										
	3.8m	7.2										
ST-13	6 in	6.4	4.5	16	2	136.86	0.09	7.796	224	22.3	395	0.16
	1 m	8.1										
	3.9 m	6.6										
ST-14	6 in	8.6	2	18.2	2	132.00	0.10	7.698	220	22.2	390	0.16
	1 m	8.8										
	3.9 m	7.7										
ST-15	6 in	8.75	3	24	2	150.45	0.10	7.923	211	22.3	389	0.18
	1 m	9.1										
	3.85 m	8.0										
ST-16	6 in	8.8	2	18.5	2	146.56	0.16	8.048	179	22.2	398	0.20
	1 m	8.6										
	3.8 m	7.6										

Table 4: Chemical quality (Phosphate) of Rabindra Sarobar (January, 2007)

Sample Name	Phosphorus as P
ST-17 (BRC Club)	0.066
ST-18	0.084
ST-19	0.086
ST-20	0.112
ST-21	0.133
ST-4	0.137

Table 5: Chemical quality of Rabindra Sarobar (February, 2007)

Sample Name	BOD mg/l	COD mg/l	Conductivity µs	Turbidity NTU	TDS mg/l	Chloride mg/l	Phosphorus as P mg/l	Ammoniacal Nitrogenas N mg/l
ST-22	4.5	22.5	436	3	259	51.74	0.09	0.11
ST-23	5.5	28.9	409	4	243	46.19	0.053	0.16
ST-24	6	32.5	311	3	232	41.58	0.038	0.11
ST-25	6	30.5	417	1	245	54.58	0.09	0.20
ST-26	5	17.5	319	4	225	45.27	0.01	0.18
ST-27	6	27.5	390	1	231	60.05	0.09	0.17
ST-28	6.5	24	403	3	229	52.66	0.16	0.20
Average	5.13	24.21	383.57	2.71	230	101.73	0.08	0.16

100 ml. The variation in coliform counts suggest localized contamination of the lake water .The average TC and FC accordingly has been found to be 3000 per 100 ml and 900 per 100 ml respectively as depicted in Table 6.

Central Pollution Control Board has classified surface water as per water quality criteria and designated best-use. Using the same standard the Rabindra Sarobar Lake can be classified as class 'D'. However if the lake water could be protected from organic pollution through implementation of environmental management plan in a short term measure, the lake could be upgraded to class 'C' in near future. But by undertaking Environmental Management Program (EMP) as a long term measure, Rabindra Sorabor could be further upgraded to class 'B'.

The sediments of Rabindra Sarobor were collected from two locations for assessment of Zinc, Cadmium, Copper, Lead and Chromium. The analysis results indicated presence of all the above heavy metals in the sedimentary deposit at the bottom of the lake. These accumulations of heavy metals could be due to disposal of solid waste, immersion of idols etc.

The concentration of heavy metals in the bottom sediment of the lake has been presented in Table 7. The results indicated that there is a risk of heavy metal coming in food through fish. However the concentrations of heavy metal are not in the danger level to cause carcinogenicity. Thus, disposal of solid waste needs to be restricted immediately to curb on the increase of heavy metal in the lake.

RESULT AND DISCUSSION

From the water quality monitoring study the following findings are made

1. Rabindra Sarobar Lake can be classified as class 'D'(Preparation of Comprehensive Rejuvenation Plan (CRJP) of Rabindra Sarobar, Kolkata',2007) However if the lake water could be protected from organic pollution through implementation of environmental management plan in a short term measure, the lake could be upgraded to class 'C' in near future. But by undertaking Environmental Management Program (EMP) as a long term measure, Rabindra Sorabor could be further upgraded to class 'B'.
2. Manual removal of water hyacinth is recommended to keep Rabindra Sarobar free from water hyacinth. As recently, Rabindra Sarobar has been made free from water hyacinth, so immediate measure need to be taken for manual control of growth of water hyacinth. It is suggested that 4 (four) labourers could be engaged for manual removal of water hyacinth from the lake. The program for manual removal of water hyacinth can be scheduled on regular basis, such that at least once in a week the labourers would attend each segment of the lake (the lake will be divided in 6 segments).

3. It is proposed to convert organic waste generating in Rabindra Sarobar area to organic compost through Vermiculturing. Accordingly a land has been earmarked in the south-western part of Rabindra Sarobar for the purpose. The organic waste generating in the clubs, eating-houses and water hyacinth (day-to- day lifting for maintenance of the lake) etc would be converted into compost
4. Rational solid wastes management system in Rabindra Sarobar area need to be developed in order to keep the area clean. Accordingly litter bin will be placed at regular space interval and at suitable locations of the lake area. Primary collection vehicle (3 wheeler Auto-van battery operated) will operate in the lake area for collection of solid waste from litter bins. The solid waste will be transferred in containers of skips of KMC in nearby primary transfer station (Southern Avenue) everyday. The organic waste as well as floating water hyacinth will be collected by the Auto-van separately for disposing the same at vermiculture units.
5. Carrying of plastic bag in Rabindra Sarobar area has been banned by WBPCB. Strict compliance of the same will be necessary in lake area.
6. Participation of stakeholders needs to be ensured for keeping the area litter-free. Existing Conservancy Personnel engaged in solid waste collection and disposal will be trained and utilized properly.
7. Earthen dyke should be protected from soil erosion by wooden pilling in two/ three layers along with generation of grass cover through Vetiver Grass Technology (VGT) in the catchments areas to check erosion.
8. Different fish species along with Grass Carp should be introduced for effective utilization of food from different niches of the lake. This fish culture will be done in a proper manner.
9. Unused energy generated from food chain and energy flow may be deposited as organic matter at the bottom of the lake, which will be utilized by the benthos. Taking into consideration the vast load of detritus available in the system and also the eutrophication of the lake, the culture of fishes like–Mrigal, Common Carp, Silver Carp, Magur, Koi, Rohu, Telapia, Lilentica etc. should be introduced. This culture will also help in reduction of weed in one hand and will open an avenue for revenue generation from lake.
10. Literature survey reveals that Rabindra Sarobar could be classified as class 'D' as depicted in Table 9 and 10 in the recent past report (Eco Dev Consultancy Pvt. Ltd., Feb. 2006). However, the water quality has been improved with special reference to Total Coliform and Faecal Coliform as found in the present study. The improvement of water quality within such a short period may be attributed to the strict control on bathing and washing.
11. Drainage improvement is particularly needed in the area near Ashoke Malhotra Coaching Centre and at the Ghari More near Nazrul Manch.

CONCLUSION

The average BOD (5 day, 20°C) of the lake water has been found to be 5.13 mg/l (ranging from 2 mg/l to 9 mg/l). As sewage/ sullage are not getting discharged in the lake (this has been verified during site survey), the contribution of organic load in the lake could be from residue of aquatic plants and solid wastes. The average pH values of the lake water are found to vary from 7.44 to 8.07. The pH of the lake water is remaining slightly in alkaline range which also substantiates the growth of algae in the lake. The algal growth is not very high as the BOD of the lake water ranged between 2 to 9 mg/l. The average DO (Dissolved Oxygen) level in the lake ranged between 6 to 8 mg/l at average temperature of 22o C. Hence oxygen saturation level of 67% to 88% is maintained in the pond. The average total dissolved solids in the lake have been estimated to be 230 mg/l. The average chloride concentration in the lake remains to be 101.73 mg/l (Table 6). This indicates that ground water infiltration is minimum. The study team also inspected the lake area and the salient features which pose serious threat to lake conservation may be summarized as:

Public nuisance; this includes open urination in lake as well as littering in and around the lake,

Table 6: Bacteriological Quality of Rabindra Sarobar

Date	Sampling Location	Total Coliform (MPN/100 ml)	Faecal Coliform (MPN/100 ml)	Salmonella
01/02/2007	Station-4	5000	2800	Absent
01/02/2007	Station-18	3000	1700	Absent
01/02/2007	Station-21	1600	900	
21/02/2007	Station-23	5000	180	
21/02/2007	Station-24	5000	180	
21/02/2007	Station-1	5000	500	
21/02/2007	Station-20	900	500	
21/02/2007	Station-22	350	24	
21/02/2007	Station-27	350	33	
21/02/2007	Station-17	3000	1600	
	Average	2920 ≈ 3000	840 ≈900	

Table7: Average Sediment analysis for heavy metals (mg/kg) as dry weight

Sample No.	Zn (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Cu (mg/kg)
K Model (Towards E-direction)	78.42	1.08	37.4	24.2	24.4
N Model (Towards W-direction)	100.1	1.37	41.4	28.1	29.5

Solid waste generation from hawkers in lake area, Dumping of solid waste in lake by certain irresponsible public, Use of lake area by school / office clubs and others and thus generating solid waste and spreading these in uncontrolled manner.

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