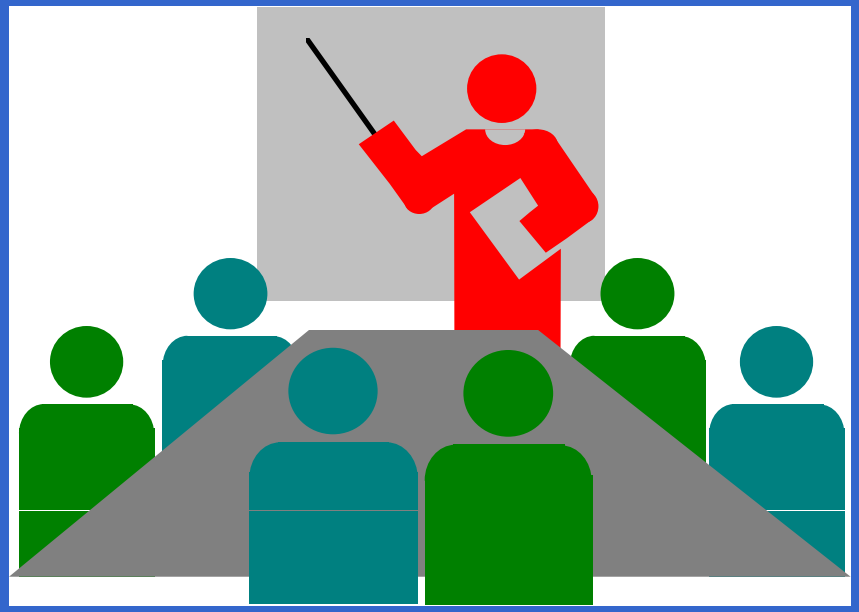

WELCOME

An approach for Restoration of Lake Ecosystems- a Case Study of Kundawada Lake, Situated Near Davangere in Central Part of Karnataka

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“An approach for Restoration of Lake Ecosystems- a Case Study of Kundawada Lake, Situated Near Davangere in Central Part of Karnataka”

Presentation By

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Introduction

Lakes are considered to be one of the most productive and biologically rich inland surface water ecosystems. Lake is defined as an aggregate of water bodies. They are either natural or man-made.

It is estimated that, India has about 4.1 million hectares of wet land of which 1.5 million hectares are natural and 2.6 million hectares are man made. A study by the Wild Life Institute of India reveals that, 70-80 % of individual fresh water marshes and Lakes have been lost during last 50 years.

Heavy dependence on ground water with an increase in population and erratic urbanization have all led to the slow disappearance of many ponds in our country leading to acute ground water depletion and pollution. If we take an example of Bangalore City, it had a distinction of having 257 Lakes in the early half of 20th century. The numbers of Lakes were reduced to 127 by 1988. Of these 127 Lakes many of the Lakes were breached and they were beyond the scope of impounding the water once again.

Agriculture run-off, Industrial effluents, Domestic sewage etc contain fertilizer components, particularly nitrogen and phosphorous, which reaches nearby Lakes and other water bodies and causes over nourishment. This gives rise to a phenomenon called Eutrophication. As a result, there is excessive growth of algal species, which is known as algal bloom. The water body or Lake soon gets filled up with algal species which quickly complete their life cycle and die thus adding lot of organic matter. Dissolved oxygen in the Lake is consumed and fish get killed so that the Lake becomes a dead pool of water devoid of plants and animals. Thus the Lake ecosystem gets completely degraded.

Hence restoration of ponds is very much necessary in the present day scenario.
The restoration of Lakes helps in

- Irrigation requirements
- Soil conservation
- Moisture conservation
- Moisture for the open wells
- Foods supply like fish and others.
- Sources of drinking water for humans and for animals.
- Recreational aspects like boating, etc

Need for the Present Investigation:

Davangere is a recently formed district situated in central part of Karnataka at longitude of 75.60, latitude of 14.40 N and altitude of 576m above msl. The district covers an area of about 6500 sq km. Davangere city is also one of the fastest growing city of the state, which has a population of around 5 lakh. As it is a District headquarters, Business and Education center, the city has a heavy floating population. The major drinking water sources for Davangere are Bhadra right bank canal and Tungabhadra River at around 15 km near Harihar. In summer this water availability both from the river and the canal will be reduced and is not sufficient to cater to the needs of the city and hence there is a shortage of water in summer.

There are three major Lakes around Davangere City. Due to rapid developments and heavy urbanization there is a reduction in catchment area. In addition to this, other human activities and discharge of sewage have caused heavy pollution to these Lakes. Hence these Lakes are at the verge of disappearance. If these Lakes are properly restored it will greatly help in solving the drinking water problems along with other environmental advantages. Keeping this in view, the present work is undertaken and as a case study.

The Study:

The study area consists of Kundawada Lake situated near the city.

Kundawada Lake is situated towards south west of Davangere City. Total area of water body is 265 acres. Earlier rainwater was the main source for this water body with partial entry of domestic sewage of Davangere city.

Specific Objectives of the Present Investigation:

- To collect the detailed information on the Lake proposed for the investigation.
- To collect literature on methodology, analytical methods, statistical analysis and the approach for the restoration of Lakes.
- To find out the sources of pollutants entering in to the Lake and to study the variations in Physico-chemical and Biological characteristics of water.
- To understand the relationship between Physico-chemical and Biological parameters of water in the Lake.

- Statistical interpretation of the data to know the correlative relationship between various Physico-chemical factors and Biological groups.
- To evolve and suggest proper methods for restoration of Lakes in general.
- Educate the local authorities to get the approval from Government agencies for financial assistance for the restoration.
- Thus the Lake developed by the methods suggested in the present investigation can be used as fresh water body for recreational purposes as well as sources of fresh water for domestic utilization during emergencies.

One Sanskrit quotation says “Kshamaya Dharitri”, meaning tolerance like earth. But we have to remember that even for that tolerance there is limit and once that limit is crossed then whole mankind will be perished. So it is “Late better than never”. We have to save water and water bodies so that they can save us. Reduce, reuse and recycle is the only solution. The present work is an effort in that direction. Let us save something for our next generation.

Finally we all have to remember one thing and that is,

“Society is a partnership not only between those who are living, but between those who are living, those who are dead, and who are to be born”

Sampling Points

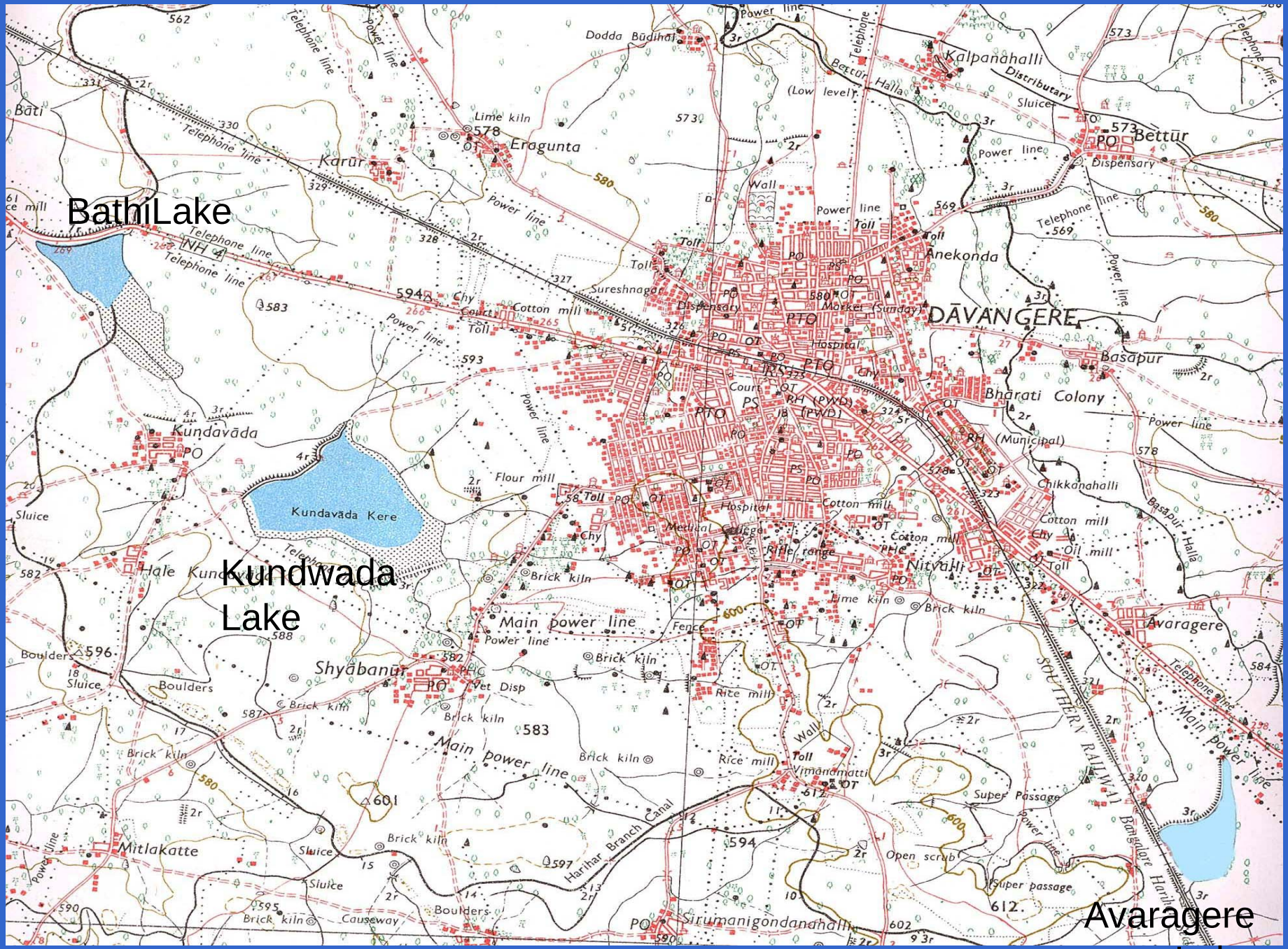
Kundawada Lake

KS-1 – Inlet Point (SW)
KS-2 – Sewage Entry Point (SE)
KS-3 – North-east Corner (NE)
KS-4 – Waste Weir Point (SW)
KS-5 – Outlet Point (SW)
KB-1- Bore well Location (E).
KB-2- Bore well Location. (NW)

Collection and Analysis of Samples:

Water samples from Kundawada lake at selected sampling locations were collected in polythene cans respectively, at monthly intervals for a period of two years (April 2004 to March 2006). Samples were collected separately in BOD bottles for the determination of dissolved oxygen with necessary precautions. The samples were analyzed for the various physico-chemical and Biological parameters. Analytical procedures reported in Standard Methods for examination of Water and Waste Water, 16th edition (1985) were followed.

After sampling, the samples were transported to the laboratory and refrigerated at 4 ^{0}C until the complete analysis is over. Each parameter is determined in triplicate and the results are confirmed with the concurrent values. To assess the quality of the ground water in the near by area of the selected water body, two bore wells were identified near lake and ground water samples were collected and tested seasonally.


BathiLake
Kundwada Lake
Avaragere Lake
DĀVANGERE
Kundavāda
Kundavāda Kere
Eragunta
Karūr
Bettūr
Kalpanahalli
Anekonda
Basapur
Bharati Colony
Chikkanahalli
Nitvalli
Avaragere
Shyabanur
Mitlakatte
Sirumanigondanahalli
Harihar Branch Canal
Main power line
Bangalore Harihar Railway
Dodda Būdihal
Sureshnagar
Vimanamatti

KUNDAWADA LAKE

Station-1, Inlet Point

Table 4.1 Station (1)-KS-1 Inlet Point (SW), KUNDAWADA LAKE, June 2004 to May 2006											
Months	Temperature		Turb	pH	COND	TDS	DO	BOD	COD	TH	TA
	Air	Water									
Jun-04	34	33	4	8	416	230	9	5	17	78	66
July	31	30	6	8	347	191	9	4.6	14	65	62
August	29	28	5	7	335	183	9	4.2	12	55	58
September	29	28	4	8	336	185	9	4.3	12	48	60
October	29	27	4	8	348	193	9	4.5	13	52	64
November	29	27	3	8	388	209	9	4.7	14	60	68
December	26	25	3	8	360	203	9	5.8	17	61	76
Jan-05	25	24	3	8	427	234	8	5.9	18	67	72
February	30	29	4	8	461	257	8	6.2	18	74	83
March	32	31	5	8	447	251	8	7.1	18	83	88
April	34	33	4	8	503	262	8	7	20	80	85
May	33	32	3	8	512	276	8	7.3	19	83	92
Jun-05	35	33	5	8	427	238	9	5.1	16	81	69
July	31	29	7	8	363	198	9	4.7	14	68	65
August	30	29	6	7	330	187	9	4.3	14	58	62
September	29	27	5	8	339	189	9	4.3	14	51	64
October	29	28	5	8	370	205	9	4.7	15	55	67
November	28	26	4	8	379	220	9	4.9	15	63	72
December	26	24	5	8	368	209	9	6	19	62	79
Jan-06	26	25	4	8	431	238	9	6.1	20	70	74
February	30	29	5	8	473	262	9	6	20	77	86
March	32	30	5	8	485	270	8	7.3	24	86	91
April	34	33	4	8	525	290	8	7.5	24	84	88
May	35	33	4	8	517	283	8	7.6	22	89	95

Table 4.1 Station (1)-KS-1 Inlet Point (SW), KUNDAWADA LAKE, June 2004 to May 2006													
Months	Ca	Mg	Na	K	SO4	Cl	HCO3	PO4	TN	KJN	Fe	F	Si
Jun-04	17	7.4	42.8	6	12.4	25	73	1.81	0.26	0	0	0.4	0.9
July	13	7.1	39.5	5	10.6	22	51	1.71	0.25	0	0	0.21	0.8
August	12	5.8	35.8	5	9.9	24	48	1.72	0.25	1	0	0.26	0.92
September	12	4.9	38.5	4	9.8	21	53	1.86	0.24	0	0	0.24	0.93
October	12	5.1	38.4	5	9.8	18	64	1.89	0.2	0	0	0.28	0.96
November	13	6.5	41.5	5	9.7	22	68	1.92	0.21	0	0	0.36	0.92
December	15	6.1	42.8	5	11.4	18	59	1.95	0.24	1	0	0.31	0.9
Jan-05	15	7.3	48.9	6	11.7	23	76	1.95	0.22	0	0	0.29	0.8
February	17	7.9	49.5	7	11.9	25	83	2.08	0.24	0	0	0.38	0.7
March	19	8.9	51.2	7	12.4	26	81	2.16	0.28	1	0	0.36	0.6
April	19	8.7	50.1	7	12.5	31	88	2.02	0.28	1	0	0.4	0.65
May	19	8.8	52.4	8	12.9	27	84	2.19	0.29	1	0	0.43	0.58
Jun-05	18	7.7	43.1	6	12.6	26	75	2.48	0.28	1	0	0.3	1
July	14	7.4	40	5	10.8	24	53	2.4	0.29	0	0	0.23	0.9
August	13	6.1	36.4	5	10.1	25	50	2.15	0.28	1	0	0.29	0.94
September	12	5.3	39.1	5	10	23	55	2	0.27	1	0	0.27	0.95
October	12	5.4	39	5	10	20	67	2.03	0.23	0	0	0.29	0.97
November	14	6.8	42	5	9.2	23	71	2.45	0.22	0	0	0.35	0.91
December	15	6.4	44.2	5	9.7	19	62	2.58	0.27	0	0	0.32	0.86
Jan-06	15	7.7	49.3	7	10	25	78	2.65	0.25	1	0	0.3	0.81
February	17	8.5	50.2	7	11.7	27	85	2.6	0.27	1	0	0.39	0.76
March	21	9.4	51.5	7	12.6	27	83	2.71	0.31	1	0	0.37	0.74
April	21	9.2	57.6	8	15.9	33	90	2.56	0.32	1	0	0.41	0.7
May	21	9.4	59.9	8	13.3	30	87	2.63	0.32	1	0	0.44	0.63

Table 4.2 Station 2- KS-2 : Sewage Entry Point (SE) KUNDAWADA LAKE June 2004 to May 2006											
Months	Temperature		Turb	pH	COND	TDS	DO	BOD	COD	TH	TA
	Air	Water									
Jun-04	34	34	5	6.4	488	273	7.1	8.7	26.3	84	59
July	31	30	6	6.3	427	230	6.8	9.3	28.1	71	53
August	29	28	5	6.3	413	223	6.7	9.8	27.6	63	45
September	29	28	5	6.5	480	270	6.8	9.7	26.5	55	52
October	28	27	6	6.7	439	235	6.8	10.1	28.4	52	51
November	28	27	4	6.6	457	254	6.5	9.9	28.1	60	57
December	26	25	4	6.6	448	240	6.5	9.8	26.7	64	64
Jan-05	25	24	4	6.8	535	290	6.2	9.9	25.8	73	64
February	30	29	5	6.9	560	310	6.2	9.5	27.7	78	69
March	32	31	5	6.9	530	295	5.8	10	26.9	96	64
April	34	33	5	6.9	554	315	5.7	10.2	28.4	94	73
May	33	32	4	7.1	572	318	5.8	9.8	27.1	96	70
Jun-05	35	33	6	6.3	507	281	7	8.9	28.1	85	60
July	31	29	8	6.2	430	237	6.7	9.5	30.1	72	54
August	30	29	6	6.3	412	229	6.6	10.1	29.4	63	47
September	29	27	6	6.4	395	215	6.6	10.1	28.3	54	54
October	29	28	6	6.6	429	237	6.6	10.1	30.6	51	53
November	28	26	5	6.7	458	254	6.4	10.2	30.3	62	59
December	26	24	6	6.5	446	248	6.4	9.8	28.8	66	66
Jan-06	26	25	5	6.7	493	280	6.1	10.4	27.7	71	66
February	30	29	5	6.8	524	295	6.1	10.7	29.9	80	71
March	32	30	6	6.9	549	312	5.6	10.9	28.9	98	66
April	34	33	5	6.9	570	315	5.6	10.6	28.2	96	75
May	35	33	5	7.2	565	313	5.7	10.9	29.2	95	71

Table 4.2 Station 2- KS-2 : Sewage Entry Point (SE) KUNDAWADA LAKE June 2004 to May 2006													
Months	Ca	Mg	Na	K	SO4	Cl	HCO3	PO4	TN	KJN	Fe	F	Si
Jun-04	16.2	8.7	52.7	7.5	14.8	44	87	2.2	0.37	0.52	0.15	0.32	0.6
July	14.5	8.3	54.3	7.2	14.9	42	65	2.3	0.37	0.59	0.23	0.17	0.65
August	12.8	6.9	55.5	6.6	15.6	44	62	2.5	0.33	0.63	0.37	0.29	0.81
September	11.9	6.1	47.8	5.9	14.7	39	59	2.4	0.32	0.61	0.39	0.23	0.84
October	12.5	5.2	59.2	5.7	15	39	73	2.6	0.28	0.55	0.58	0.26	0.83
November	13.8	6.6	50	6.5	15.8	36	79	2.45	0.29	0.57	0.54	0.31	0.76
December	14.7	6.5	53.4	7.3	14.8	33	70	2.4	0.31	0.68	0.49	0.29	0.7
Jan-05	15.3	7.7	58.6	8.2	14.4	39	85	2.38	0.28	0.59	0.41	0.33	0.71
February	16.8	8.4	57.3	8.1	12.7	43	88	2.29	0.33	0.64	0.31	0.36	0.67
March	19.4	9.5	57.5	9.2	14.5	46	92	2.57	0.39	0.69	0.33	0.31	0.64
April	19.1	9.9	60.2	8.9	16.7	48	88	2.57	0.37	0.62	0.29	0.37	0.66
May	20.3	10.3	63.8	9.4	15.2	48	90	2.32	0.4	0.67	0.26	0.41	0.62
Jun-05	16.4	9	52.9	8	15.1	46	89	2.3	0.38	0.55	0.2	0.3	0.65
July	14.7	8.5	54.6	7.7	13.4	43	67	2.4	0.39	0.63	0.23	0.21	0.7
August	13	7.2	63.8	6.9	12.9	45	64	2.7	0.34	0.63	0.39	0.28	0.81
September	11.2	6.3	63.5	6.3	12.2	40	60	2.7	0.33	0.62	0.43	0.35	0.9
October	12.8	5.4	63.7	6.1	11.3	40	76	2.7	0.28	0.65	0.62	0.3	0.89
November	14.1	6.8	63.4	6.8	10.8	38	84	2.5	0.29	0.65	0.77	0.38	0.84
December	15.1	6.8	63.9	7.8	11.2	35	74	2.4	0.32	0.59	0.73	0.37	0.8
Jan-06	15.6	8	66.2	8.5	11.9	41	88	2.8	0.28	0.69	0.73	0.4	0.67
February	17.1	8.7	67.8	8.4	13.1	46	92	2.9	0.35	0.67	0.82	0.45	0.65
March	19.6	9.6	67.7	9.5	13.7	48	95	2.8	0.4	0.71	0.58	0.44	0.65
April	19.5	10.3	70.7	9.2	16.9	48	93	2.7	0.38	0.67	0.71	0.47	0.69
May	20.3	10.6	74.3	9.7	15.8	51	91	3	0.41	0.79	0.77	0.5	0.53

Table 4.3 Station (3)-KS-3 North East Corner (NE) KUNDAWADA LAKE , June 2004 to May 2006											
Months	Temperature		Turb	pH	COND	TDS	DO	BOD	COD	TH	TA
	Air	Water									
.June-2004	34	34	4	7.6	490	268	7.9	7.8	23.8	82	61
July	31	30	5	7.7	436	231	8.2	7.5	24.4	69	57
August	28	28	5	7.5	423	225	7.9	7.7	23.5	60	52
September	28	28	4	7.3	397	212	8.1	7.4	23.9	53	58
October	28	28	5	7.2	430	230	7.9	8.1	26.2	53	55
November	28	27	4	7.4	447	242	8	7.9	25.3	61	61
December	25	25	4	7.3	443	235	7.9	8.3	24.6	61	66
Jan-05	26	25	3	7.4	478	263	7.7	8.1	25.1	68	68
February	31	30	4	7.7	517	278	7.5	8.3	25.9	75	77
March	33	32	4	7.5	525	299	7.2	8.2	26.4	88	76
April	34	33	5	7.7	565	315	6.9	8.9	24.7	88	82
May	33	32	4	7.7	590	329	6.9	8.8	25.8	90	81
Jun-05	35	33	5	7.5	478	275	8.2	7.4	24.2	84	63
July	31	29	6	7.6	430	240	8.1	7.1	25.5	73	59
August	30	29	6	7.5	409	218	7.7	7.9	24.5	64	54
September	29	27	5	7.4	376	205	8	7.5	24.8	56	59
October	29	28	5	7.1	410	235	7.6	8.3	27.2	55	57
November	28	26	5	7.5	430	245	7.8	7.9	26.3	63	63
December	26	24	5	7.4	415	230	7.7	7.8	25.2	62	68
Jan-06	26	25	4	7.3	469	270	7.5	8.2	26.1	69	70
February	30	29	4	7.6	497	285	7.3	8.5	26.8	79	79
March	32	30	5	7.6	540	295	6.8	8.5	27.3	92	78
April	34	33	5	7.7	557	307	6.5	8.4	25.6	91	84
May	35	33	5	7.9	568	316	6.5	8.5	26.4	95	85

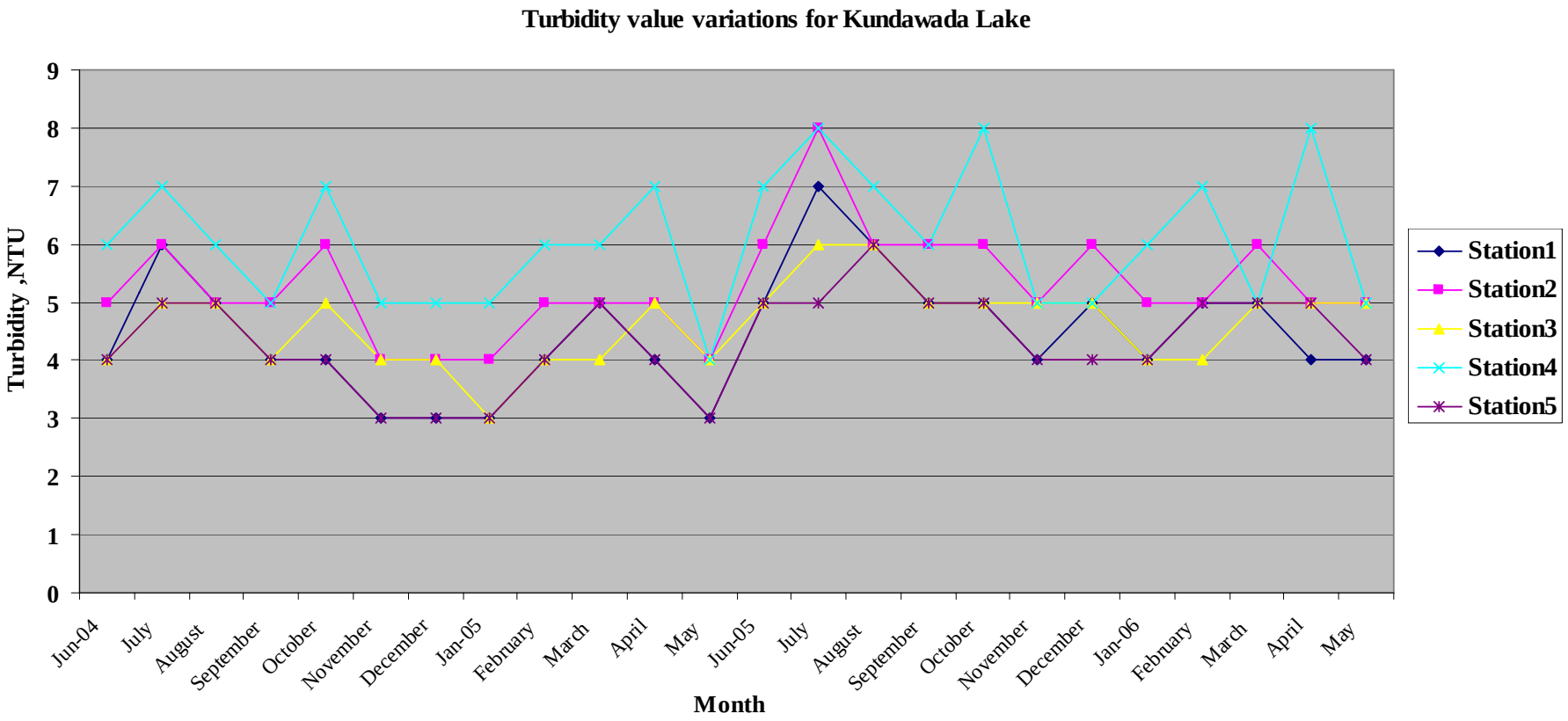
Table 4.3 Station (3)-KS-3 North East Corner (NE) KUNDAWADA LAKE , June 2004 to May 2006													
Months	**Ca**	**Mg**	**Na**	**K**	**SO4**	**Cl**	**HCO3**	**PO4**	**TN**	**KJN**	**Fe**	**F**	**Si**
.June-2004	16.5	8.5	49.3	6.8	13.9	42	84	2.13	0.34	0.57	0.14	0.36	0.65
July	14.6	8.1	44.1	7	12.9	39	64	2.05	0.35	0.53	0.25	0.19	0.68
August	12.6	6.6	42.3	6.4	11.4	43	60	2.41	0.3	0.6	0.38	0.28	0.74
September	11.2	5.7	44.5	5.4	11.3	36	57	2.29	0.29	0.52	0.37	0.24	0.79
October	12.2	5.2	45.8	5.2	10.8	35	70	2.32	0.24	0.57	0.49	0.26	0.81
November	13.7	6.5	46.4	5.6	10.5	35	74	2.13	0.24	0.55	0.67	0.29	0.92
December	14.6	6.4	46.7	5.9	10.7	31	66	2.45	0.27	0.6	0.71	0.29	0.87
Jan-05	15.1	7.6	54.5	7.8	11.2	36	80	2.39	0.25	0.54	0.7	0.28	0.72
February	16.5	8.2	54.3	7.8	12.4	39	86	2.47	0.29	0.61	0.76	0.31	0.67
March	19.2	9.2	58.2	8.3	13.1	43	88	2.39	0.34	0.63	0.65	0.31	0.7
April	18.9	9.1	58.9	8.2	16.2	46	85	2.53	0.35	0.67	0.73	0.33	0.65
May	19.5	9.4	61.8	8.7	14.6	44	88	2.47	0.36	0.7	0.78	0.37	0.63
Jun-05	16.6	8.7	49.5	7.1	14.1	44	87	2.14	0.35	0.59	0.16	0.38	0.66
July	14.8	8.3	44.5	7.3	13.3	41	67	2.3	0.36	0.6	0.27	0.21	0.63
August	12.8	6.7	42.8	6.7	11.9	45	63	2.19	0.31	0.57	0.4	0.3	0.79
September	11.5	5.9	44.9	5.7	11.8	34	60	2.1	0.32	0.52	0.4	0.3	0.83
October	13	5.5	46.2	5.4	11.2.	38	73	2.1	0.26	0.49	0.51	0.31	0.84
November	14	6.6	46.9	5.9	11	38	77	2.2	0.28	0.54	0.47	0.32	0.74
December	15	6.5	47.2	7.2	11.3	34	69	2.1	0.3	0.55	0.45	0.32	0.72
Jan-06	16.2	7.9	55	8	11.5	39	82	2.2	0.29	0.51	0.45	0.31	0.69
February	17.6	8.5	54.8	8.3	12.9	42	87	2.3	0.33	0.57	0.41	0.35	0.63
March	20.4	9.5	55.7	8.4	13.6	46	89	2.3	0.37	0.63	0.35	0.4	0.65
April	20.2	9.6	59.4	8.7	16.7	49	86	2.3	0.37	0.65	0.31	0.45	0.61
May	21.1	9.9	62.2	8.9	15.1	49	90	2.4	0.39	0.67	0.27	0.46	0.59

Table 4.4 Station (4)-KS4 Waste weir point (SW) KUNDAWADA LAKE June 2004 to May 2006											
Months	Temperature		Turb	pH	COND	TDS	DO	BOD	COD	TH	TA
	Air	Water									
Jun-04	34	34	6	6.3	452	248	6.5	8.2	25.7	82	61
July	31	30	7	6.2	385	214	6.5	8.9	26.8	73	55
August	29	28	6	6.3	361	196	6.4	9.1	27.6	61	47
September	29	28	5	6.2	347	191	6.9	9	27.2	56	51
October	28	27	7	6.6	376	216	6.6	9.3	28.4	50	49
November	28	27	5	6.5	395	219	6.8	9.2	28.3	58	56
December	26	25	5	6.5	381	218	6.3	8.9	28	62	60
Jan-05	25	24	5	6.6	436	243	6	8.8	26.3	71	65
February	30	29	6	6.9	465	257	5.8	8.4	25.9	75	68
March	32	31	6	6.8	478	268	5.5	8.6	26.5	90	62
April	34	33	7	6.8	492	275	5.3	9.2	28.8	85	70
May	33	32	4	6.9	509	284	5.2	9	27.8	88	69
Jun-05	35	33	7	6.2	451	258	6.7	8.8	26.5	83	63
July	31	29	8	6.1	378	210	6.6	9.1	27.7	74	57
August	30	29	7	6.2	370	204	6.7	9.3	28.6	63	49
September	29	27	6	6.3	355	195	6.5	9.2	29.2	57	54
October	29	28	8	6.7	391	215	6.6	9.5	29.6	52	52
November	28	26	5	6.4	407	228	6.9	9.3	30.3	60	59
December	26	24	5	6.4	395	210	6.5	9.4	30.1	64	63
Jan-06	26	25	6	6.7	447	245	6.2	8.5	28.2	73	68
February	30	29	7	6.8	470	260	5.9	9.9	27.7	77	71
March	32	30	5	6.9	492	270	5.9	9.8	27.4	93	65
April	34	33	8	6.9	502	276	5.6	9.8	30.2	97	72
May	35	33	5	6.9	517	284	5.4	9.9	29.9	90	72

Table 4.4 Station (4)-KS4 Waste weir point (SW) KUNDAWADA LAKE June 2004 to May 2006													
Months	Ca	Mg	Na	K	SO4	Cl	HCO3	PO4	TN	KJN	Fe	F	Si
Jun-04	15.3	7.7	50.2	6.8	14.2	34	77	2.09	0.3	0.63	0.17	0.3	0.8
July	13.3	7.5	42.1	6.3	15.5	30	58	2.2	0.3	0.62	0.29	0.22	0.7
August	11.5	5.9	41.6	5.7	16.8	35	55	2.19	0.27	0.72	0.33	0.24	0.82
September	10	5.3	46	4.7	16.2	28	53	2.03	0.25	0.66	0.32	0.2	0.84
October	11.1	4.5	47.3	5.3	15.8	27	67	2.15	0.2	0.64	0.65	0.24	0.87
November	12.6	5.6	48.2	5.4	15.4	27	72	2.13	0.2	0.6	0.6	0.32	0.81
December	13.2	5.5	52.5	6.5	13.8	24	63	2.09	0.23	0.65	0.63	0.29	0.8
Jan-05	14.1	6.7	56.4	7.1	13.5	28	73	2	0.2	0.57	0.6	0.21	0.75
February	15.3	7.4	55.3	7	11.8	31	80	1.98	0.24	0.62	0.6	0.32	0.67
March	18	8.3	55.4	8.5	13.6	35	81	1.99	0.29	0.67	0.43	0.34	0.62
April	17.9	8.8	58.1	7.7	15.6	36	78	2.16	0.31	0.74	0.67	0.38	0.64
May	18.8	9.3	61.2	8.1	14.1	34	83	2.08	0.33	0.68	0.69	0.33	0.58
Jun-05	15.4	7.9	41	6.9	14.4	35	78	2.13	0.4	0.65	0.19	0.3	0.8
July	13.5	7.8	43	6.5	12.7	32	60	2.23	0.4	0.68	0.31	0.25	0.75
August	11.7	6.2	44.6	5.9	11	37	56	2.26	0.3	0.75	0.35	0.25	0.87
September	10.2	5.4	45.1	4.9	10.5	29	56	2.22	0.3	0.7	0.33	0.25	0.83
October	11.3	4.6	46.2	5.2	10.1	28	75	2.3	0.25	0.7	0.39	0.3	0.71
November	12.9	5.8	46.4	5.3	10	27	74	2.24	0.25	0.65	0.36	0.37	0.7
December	13.5	5.9	48	6.4	10.2	26	65	2.29	0.3	0.7	0.32	0.35	0.65
Jan-06	14.5	7	49.3	7.3	11	30	72	2.31	0.25	0.72	0.37	0.35	0.61
February	15.7	7.7	51.2	7.3	12.2	33	82	2.38	0.31	0.75	0.33	0.38	0.63
March	18.3	8.9	50.8	8.9	13.1	37	83	2.34	0.35	0.69	0.35	0.41	0.61
April	18.2	9.1	50.7	7.9	16.1	39	80	2.46	0.4	0.74	0.39	0.41	0.69
May	18.3	9.6	52.5	8.5	15	37	86	2.38	0.4	0.76	0.31	0.42	0.62

Table 4.5 Station (5)-KS-5 Outlet point (SW) KUNDAWADA LAKE June 2004 to May 2006											
Months	Temperature		Turb	pH	COND	TDS	DO	BOD	COD	TH	TA
	Air	Water									
Jun-04	34	34	4	8.1	427	238	8.3	5.1	16.9	80	70
July	31	30	5	7.9	360	205	8.7	4.8	14	69	66
August	29	28	5	7.2	341	188	8.8	4.7	13.5	58	63
September	29	28	4	7.4	347	198	8.9	4.8	13.7	53	65
October	29	27	4	7.7	367	206	8.8	4.8	13.7	56	69
November	29	27	3	7.9	403	220	7.8	5.2	15	65	74
December	26	25	3	7.7	386	217	7.4	6	18.4	68	81
Jan-05	25	24	3	8.2	436	248	7.9	6.3	19.3	74	76
February	30	29	4	8.2	474	265	8.1	6.6	20.1	80	87
March	32	31	5	8.2	494	272	7.6	8	23.6	85	92
April	34	33	4	8.1	523	288	7.4	7.8	22.8	81	88
May	33	32	3	8.1	534	299	7.6	7.8	22.2	87	95
Jun-05	35	33	5	8	434	239	8.1	5.3	17.2	81	71
July	31	29	5	7.7	360	205	8.5	5	15.1	70	67
August	30	29	6	7.1	345	190	8.5	4.9	14.6	60	62
September	29	27	5	7.3	355	195	8.5	4.8	14.7	55	66
October	29	28	5	7.6	375	207	8.5	4.9	14.5	57	70
November	28	26	4	7.8	409	225	7.6	5	16	66	76
December	26	24	4	7.6	386	212	7.4	5.1	17.3	69	83
Jan-06	26	25	4	8	441	244	7.5	4.9	16.2	75	78
February	30	29	5	8.1	483	266	7.6	4.7	15.2	81	89
March	32	30	5	8.1	505	279	7.7	4.4	14.7	86	94
April	34	33	5	8.1	538	295	7.6	4.7	14.9	80	90
May	35	33	4	8	549	312	7.5	5.2	16.3	86	97

Table 4.5 Station (5)-KS-5 Outlet point (SW) KUNDAWADA LAKE June 2004 to May 2006													
Months	Ca	Mg	Na	K	SO4	Cl	HCO3	PO4	TN	KJN	Fe	F	Si
Jun-04	17.6	7.5	43.2	5.7	12.7	28	75	2.34	0.29	0.52	0.19	0.4	
July	13.5	7.3	40.6	5.4	10.9	24	54	2.28	0.3	0.48	0.32	0.22	0.9
August	12.7	6.2	36.2	5.1	10.4	26	52	2.32	0.29	0.56	0.44	0.25	0.7
September	11.9	5.4	39	4.5	10.3	24	57	2.26	0.27	0.9	0.47	0.25	0.9
October	12.5	5.3	38.9	4.9	10	20	69	2.1	0.24	0.88	0.43	0.29	0.8
November	13.8	6.9	42.1	5.2	10.4	25	73	2.12	0.25	0.91	0.39	0.37	0.36
December	14.9	6.5	44.3	5.3	12.7	20	64	2.26	0.29	0.87	0.32	0.32	1
Jan-05	15.3	7.6	49.4	6.5	12.9	25	79	2.31	0.27	.0.78	0.38	0.28	0.96
February	17.5	8.5	50.1	7	13.4	27	87	2.38	0.28	1.33	0.31	0.39	0.81
March	21.5	9.3	51.7	7.3	14.8	29	84	2.46	0.32	1.28	0.34	0.37	0.73
April	19.6	9	57.8	7.7	13.9	33	92	2.42	0.32	1.6	0.28	0.5	0.65
May	19.7	9.3	58	8.4	13.3	29	97	2.39	0.34	1.75	0.29	0.46	0.65
Jun-05	17.7	7.7	43.4	5.9	13	29	76	1.96	0.3	0.53	0.21	0.41	0.58
July	13.6	7.5	41	5.7	11.1	25	55	1.92	0.31	0.5	0.33	0.23	0.55
August	12.8	6.4	36.8	5.4	10.9	27	53	1.86	0.3	0.58	0.29	0.26	0.57
September	12.1	5.6	39.2	4.7	10.8	25	58	1.83	0.28	0.51	0.31	0.27	0.6
October	12.7	5.5	39.1	5.2	10.2	21	70	1.87	0.25	0.5	0.27	0.3	0.63
November	14	7.1	42.4	5.5	9.7	26	75	1.95	0.25	0.53	0.32	0.4	0.67
December	15.1	6.7	41.6	5.2	8.5	21	66	1.96	0.31	0.57	0.3	0.35	0.63
Jan-06	15.6	7.8	49.7	4.8	10.7	26	80	1.88	0.29	0.48	0.34	0.36	0.56
February	17.8	8.7	50.4	4.3	12.1	28	88	1.71	0.3	0.47	0.31	0.45	0.53
March	21.8	9.5	51.9	4.7	12.5	30	86	1.81	0.34	0.42	0.27	0.46	0.49
April	21	9.2	58.1	4.5	16.3	34	95	1.82	0.34	0.45	0.24	0.6	0.52
May	21.1	9.2	61.3	4.7	15.1	30	98	1.89	0.36	0.52	0.26	0.53	0.47


Turbidity value variations for Kundawada Lake
Turbidity ,NTU
9
8
7
6
5
4
3
2
1
0
Jun-04
July
August
September
October
November
December
Jan-05
February
March
April
May
Jun-05
July
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December
Jan-06
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Month
Station1
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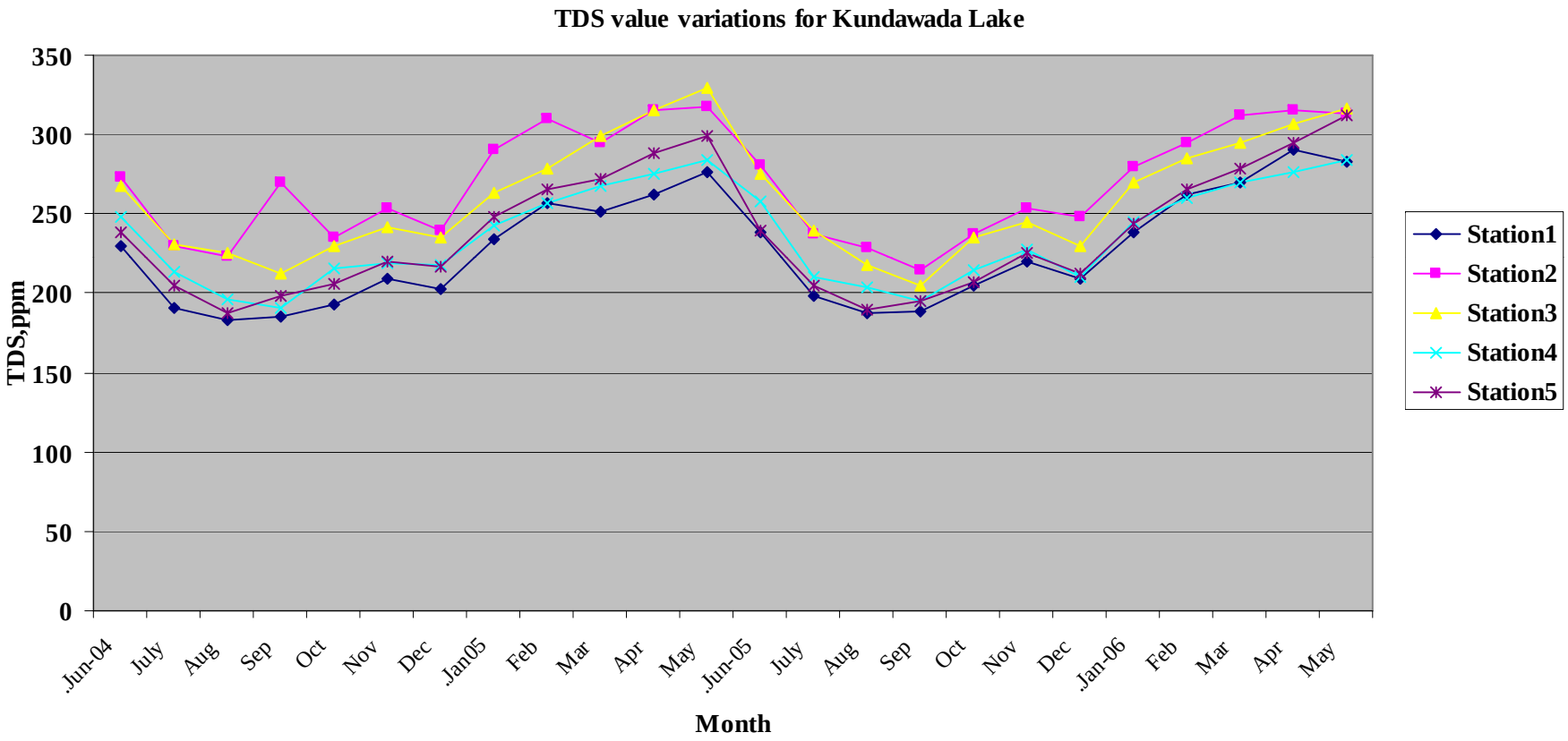
Station3
Station4
Station5


TDS value variations for Kundawada Lake
TDS,ppm
350
300
250
200
150
100
50
0
Jun-04
July
Aug
Sep
Oct
Nov
Dec
Jan05
Feb
Mar
Apr
May
Jun-05
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Jan-06
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Mar
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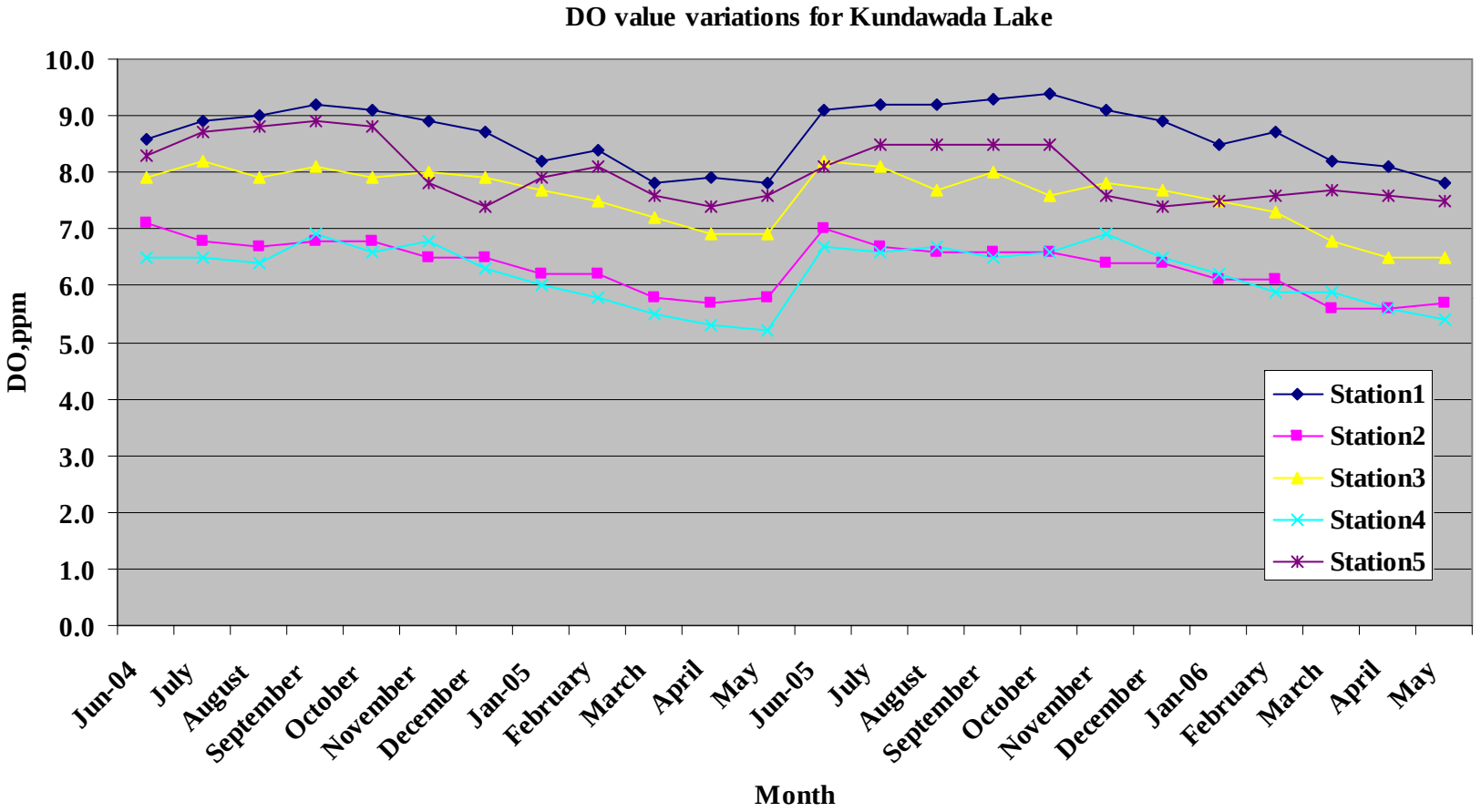
May
Month
Station1
Station2
Station3
Station4
Station5


DO value variations for Kundawada Lake
DO,ppm
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jun-04
July
August
September
October
November
December
Jan-05
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Jun-05
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Station1
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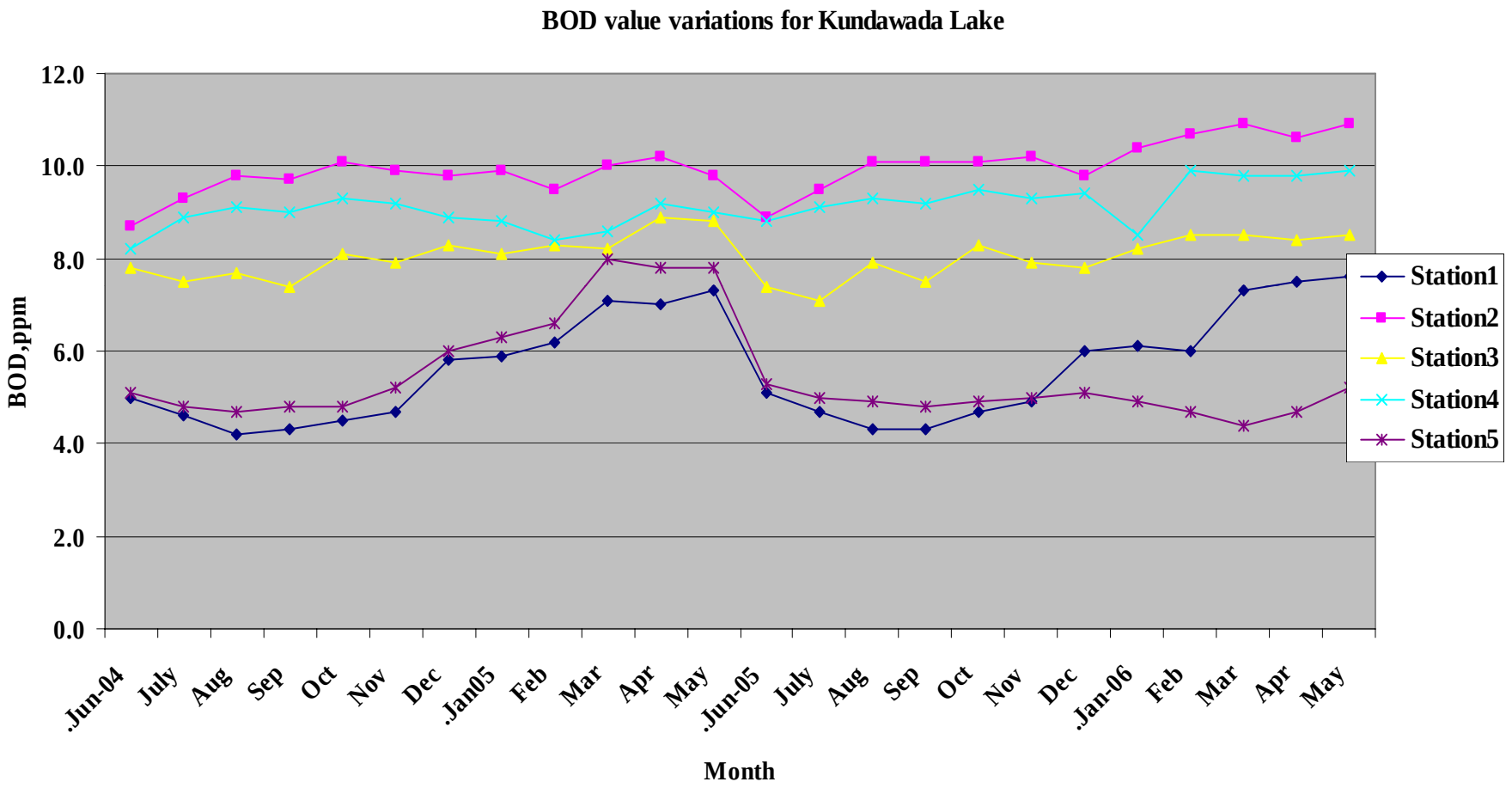
Station4
Station5


BOD value variations for Kundawada Lake
12.0
10.0
8.0
6.0
4.0
2.0
0.0
BOD,ppm
Jun-04
July
Aug
Sep
Oct
Nov
Dec
Jan05
Feb
Mar
Apr
May
Jun-05
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Month
Station1
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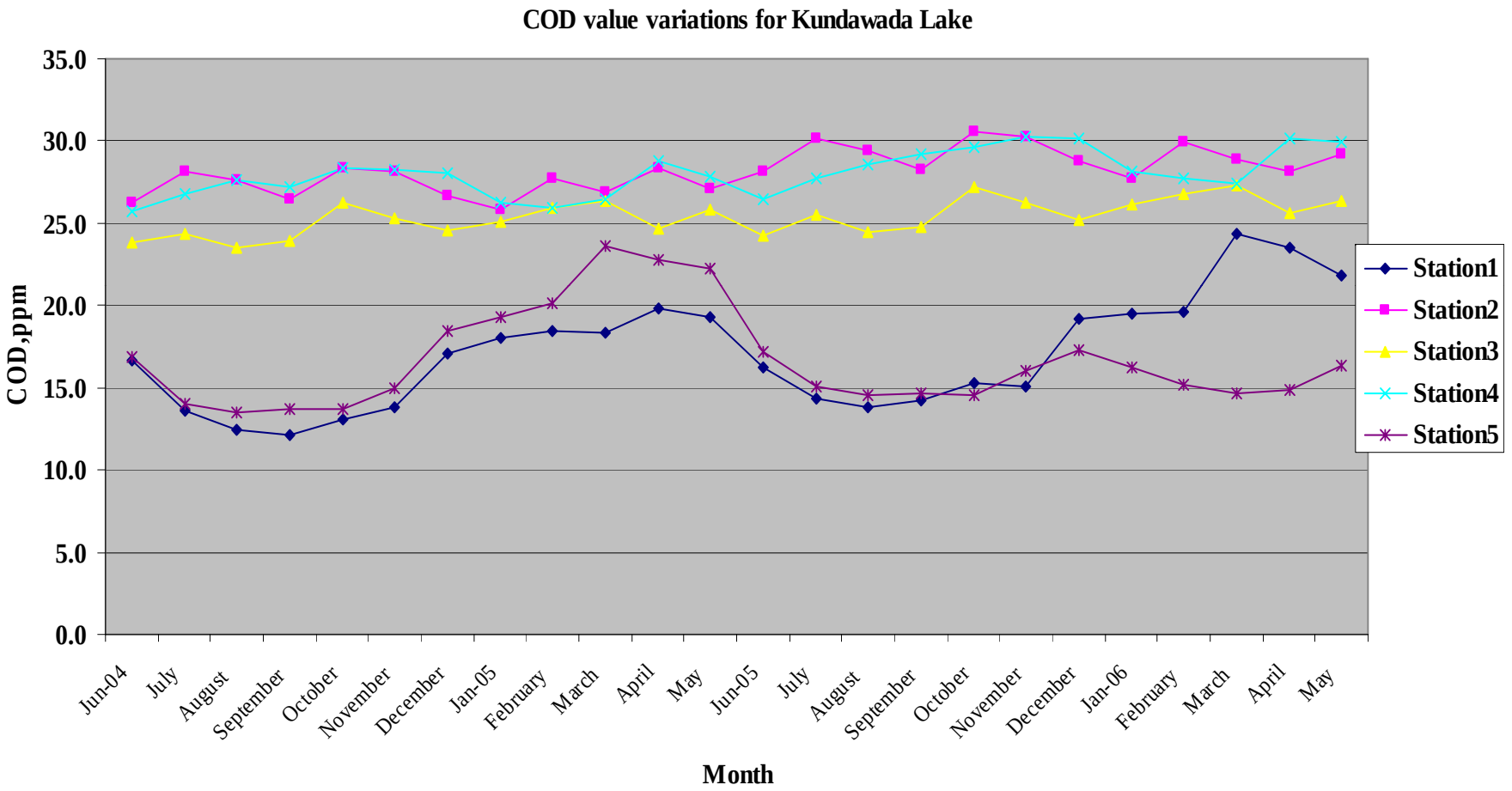
Station5


COD value variations for Kundawada Lake
COD,ppm
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jun-04
July
August
September
October
November
December
Jan-05
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April
May
Jun-05
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December
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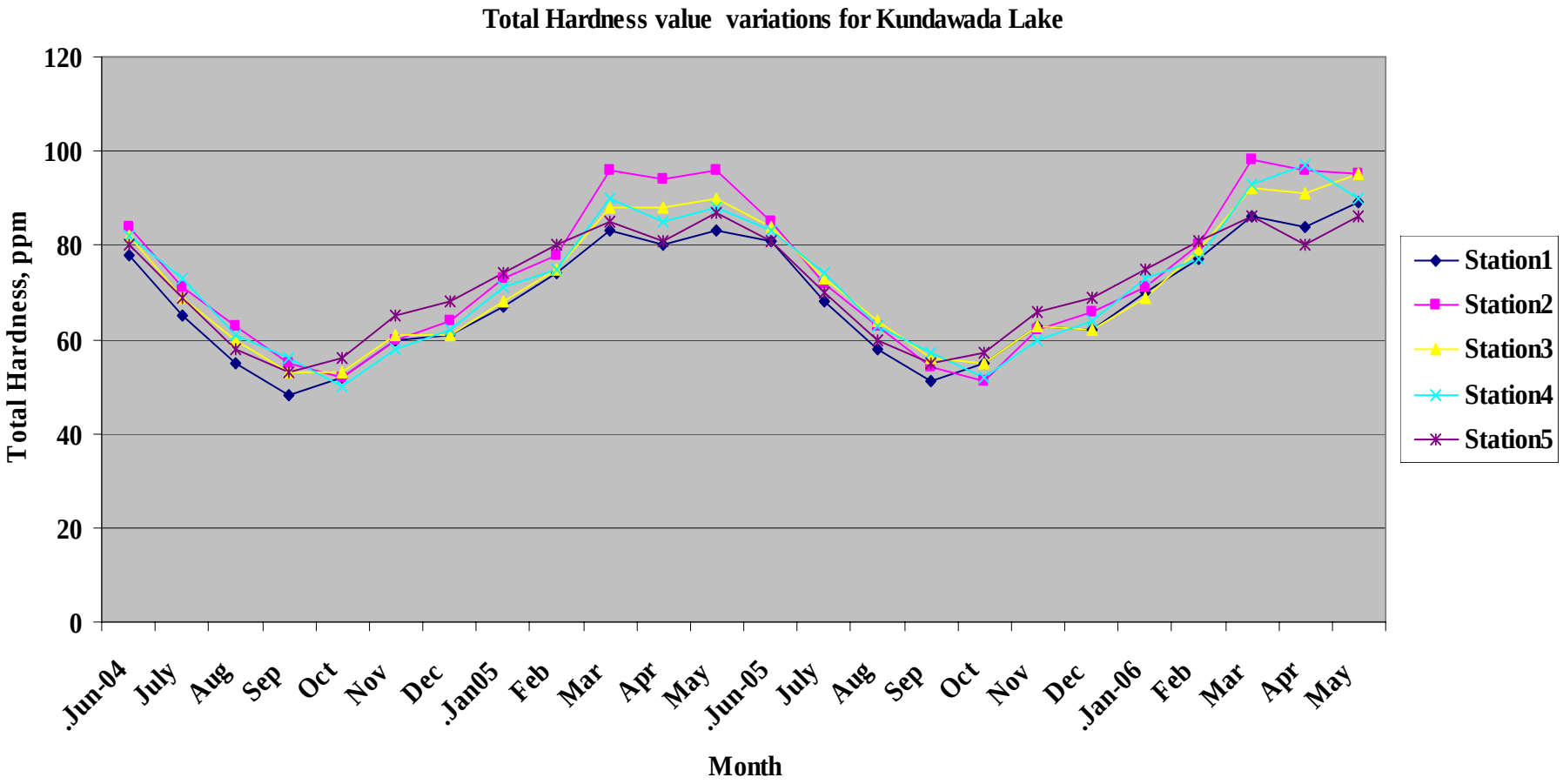
Station4
Station5


Total Hardness value variations for Kundawada Lake
Total Hardness, ppm
120
100
80
60
40
20
0
.Jun-04
July
Aug
Sep
Oct
Nov
Dec
.Jan05
Feb
Mar
Apr
May
.Jun-05
July
Aug
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.Jan-06
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Month
Station1
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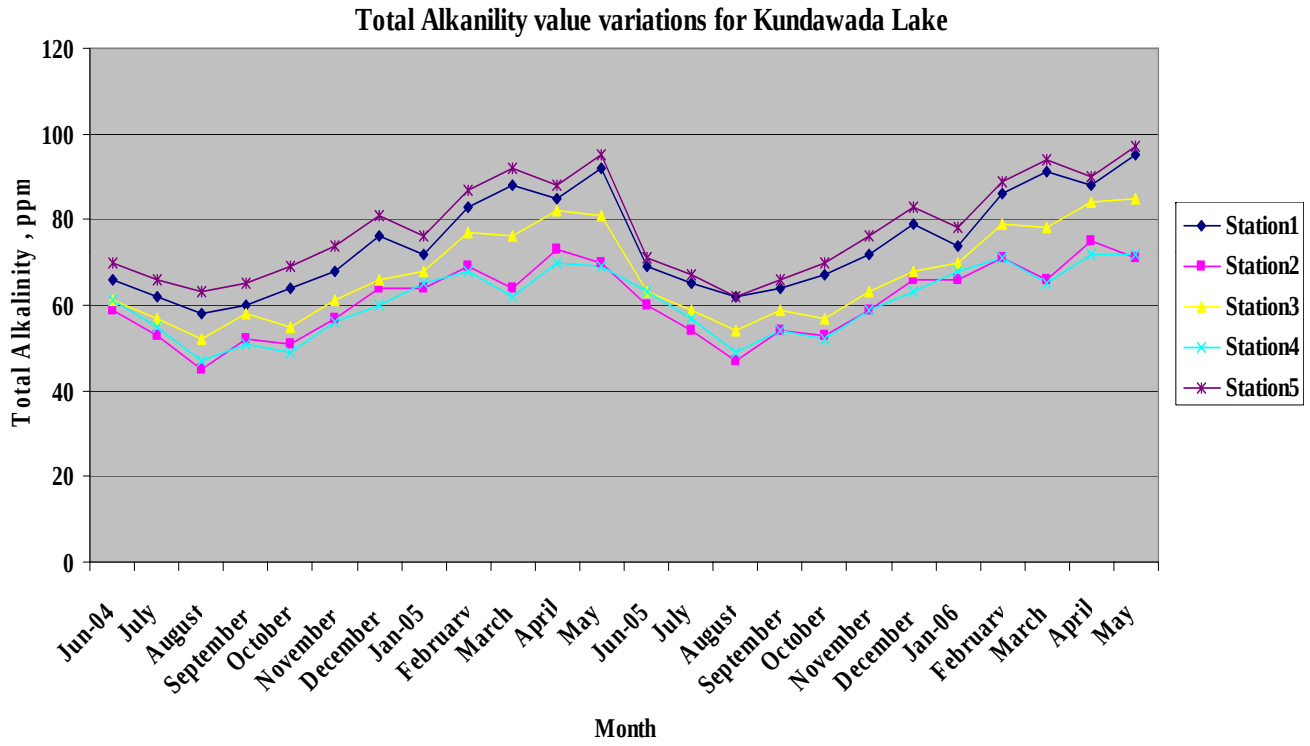
Station3
Station4
Station5


Total Alkanility value variations for Kundawada Lake
Total Alkalinity , ppm
120
100
80
60
40
20
0
Jun-04
July
August
September
October
November
December
Jan-05
February
March
April
May
Jun-05
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Jan-06
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May
Month
Station1
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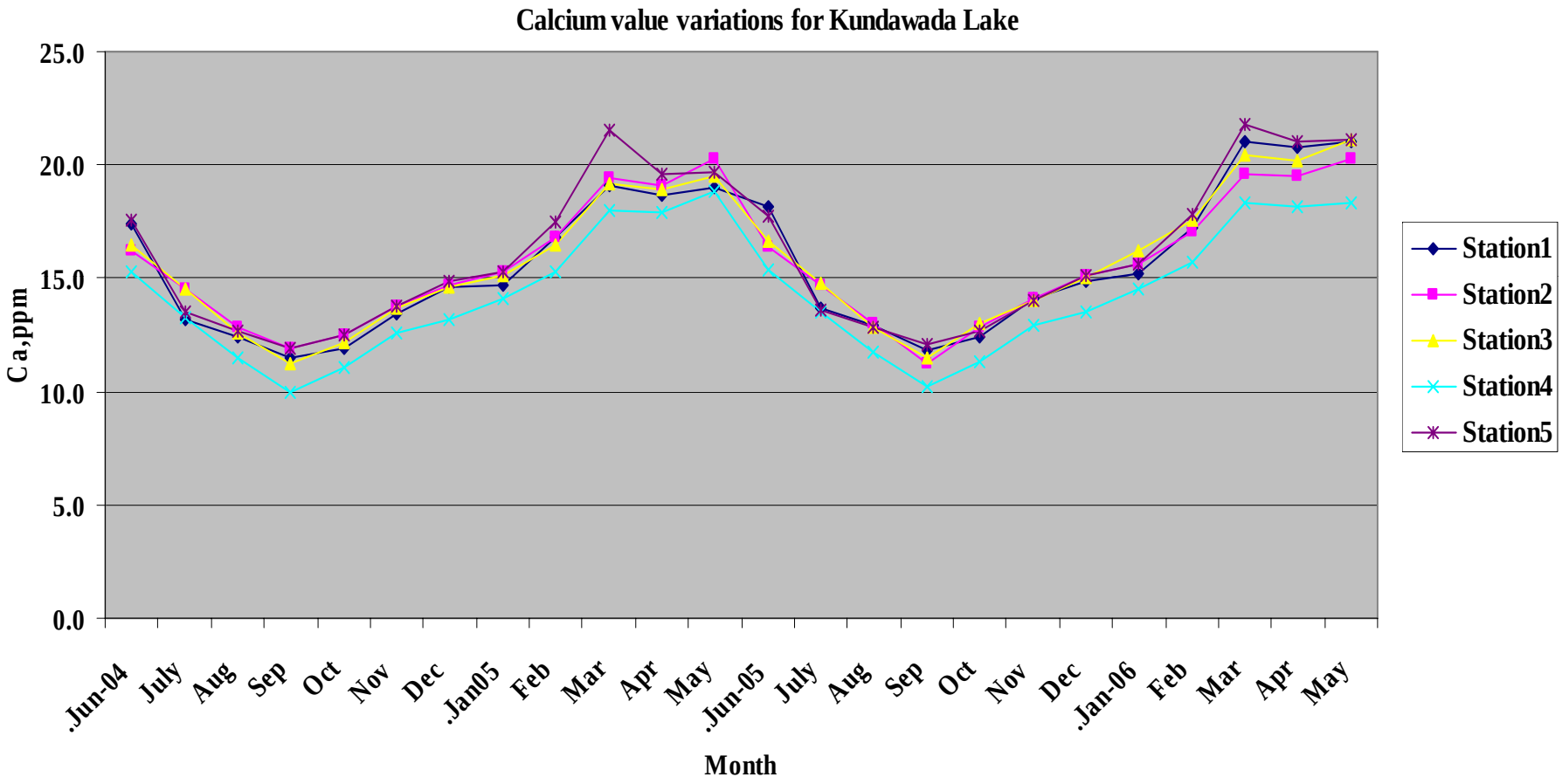
Station3
Station4
Station5


Calcium value variations for Kundawada Lake
25.0
20.0
15.0
10.0
5.0
0.0
Ca,ppm
.Jun-04
July
Aug
Sep
Oct
Nov
Dec
.Jan05
Feb
Mar
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May
.Jun-05
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.Jan-06
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Month
Station1
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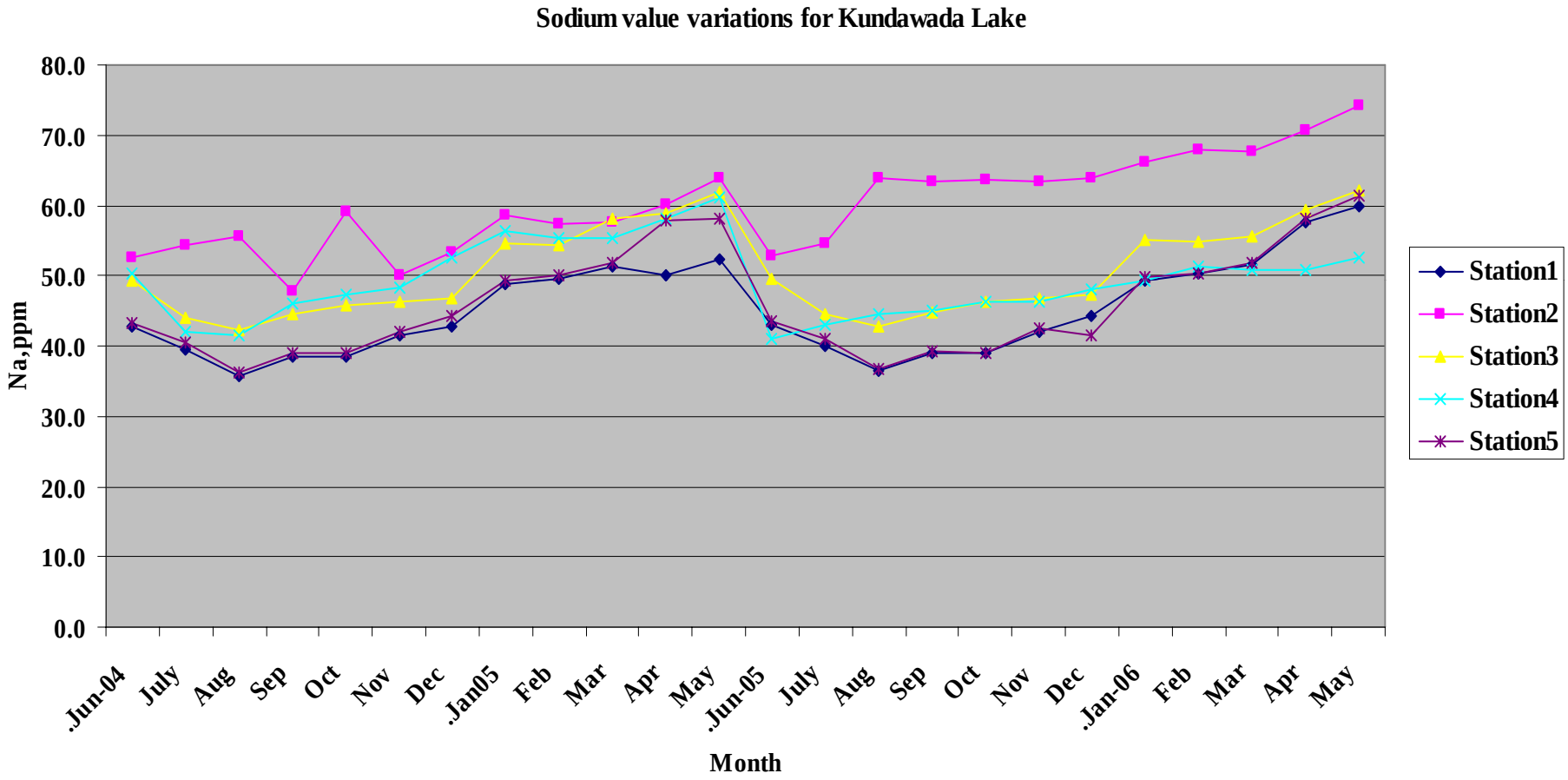
Station4
Station5


Sodium value variations for Kundawada Lake
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Na,ppm
Jun-04
July
Aug
Sep
Oct
Nov
Dec
Jan05
Feb
Mar
Apr
May
Jun-05
July
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Dec
Jan-06
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Month
Station1
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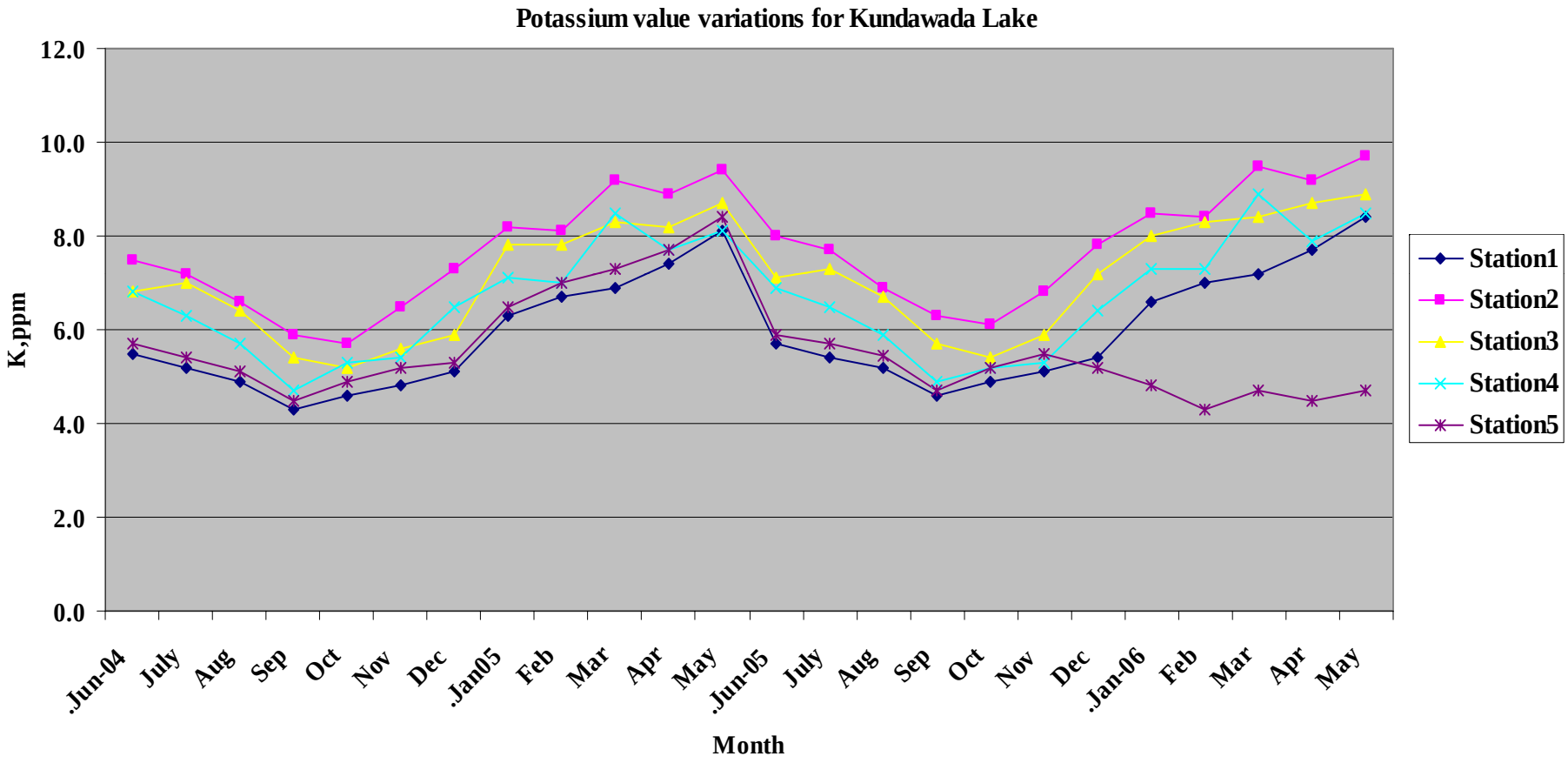
Station4
Station5


Potassium value variations for Kundawada Lake
12.0
10.0
8.0
6.0
4.0
2.0
0.0
K,ppm
Jun-04
July
Aug
Sep
Oct
Nov
Dec
Jan05
Feb
Mar
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May
Jun-05
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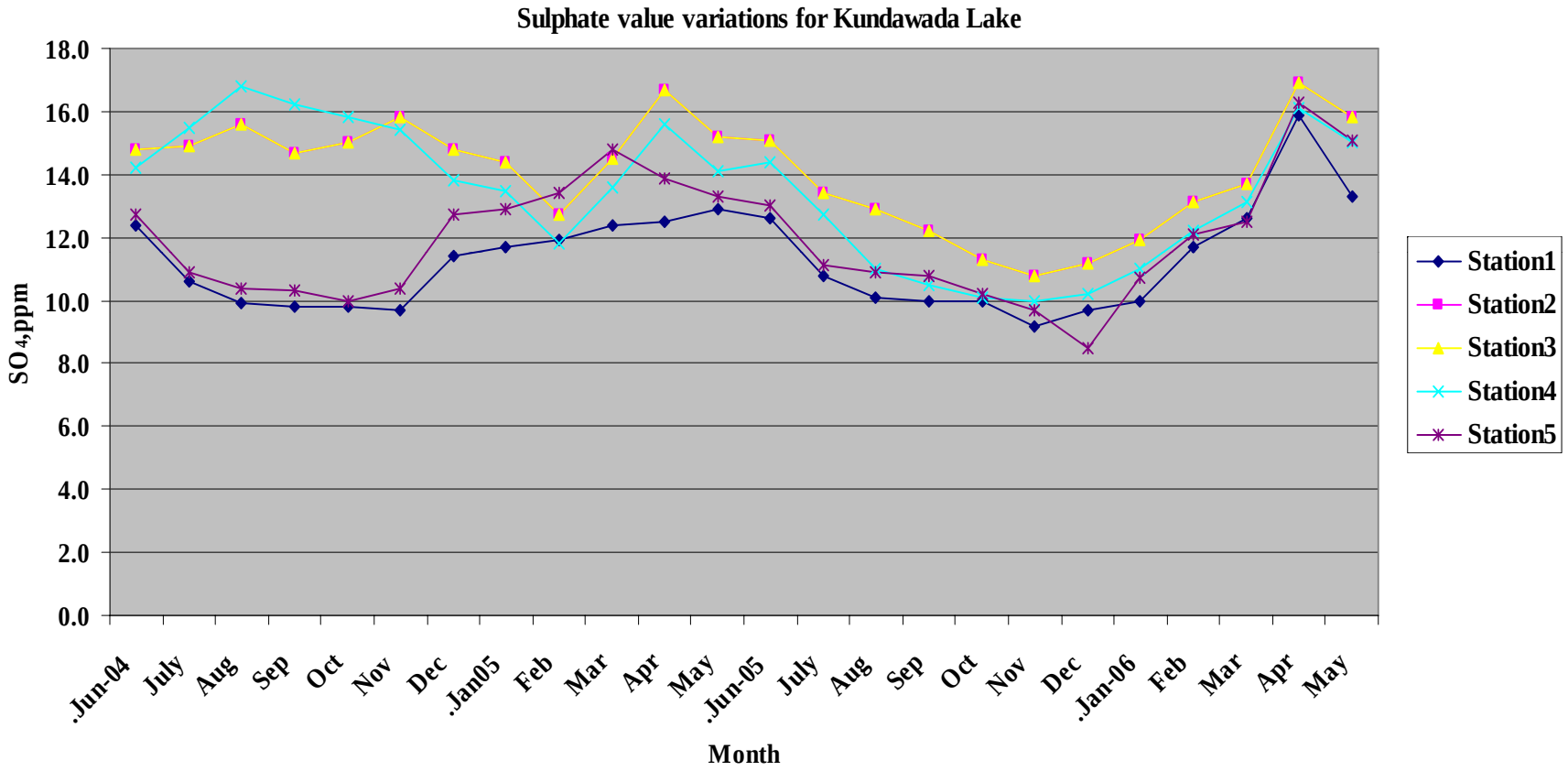
Station5


Sulphate value variations for Kundawada Lake
SO4,ppm
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
.Jun-04
July
Aug
Sep
Oct
Nov
Dec
.Jan05
Feb
Mar
Apr
May
.Jun-05
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.Jan-06
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Month
Station1
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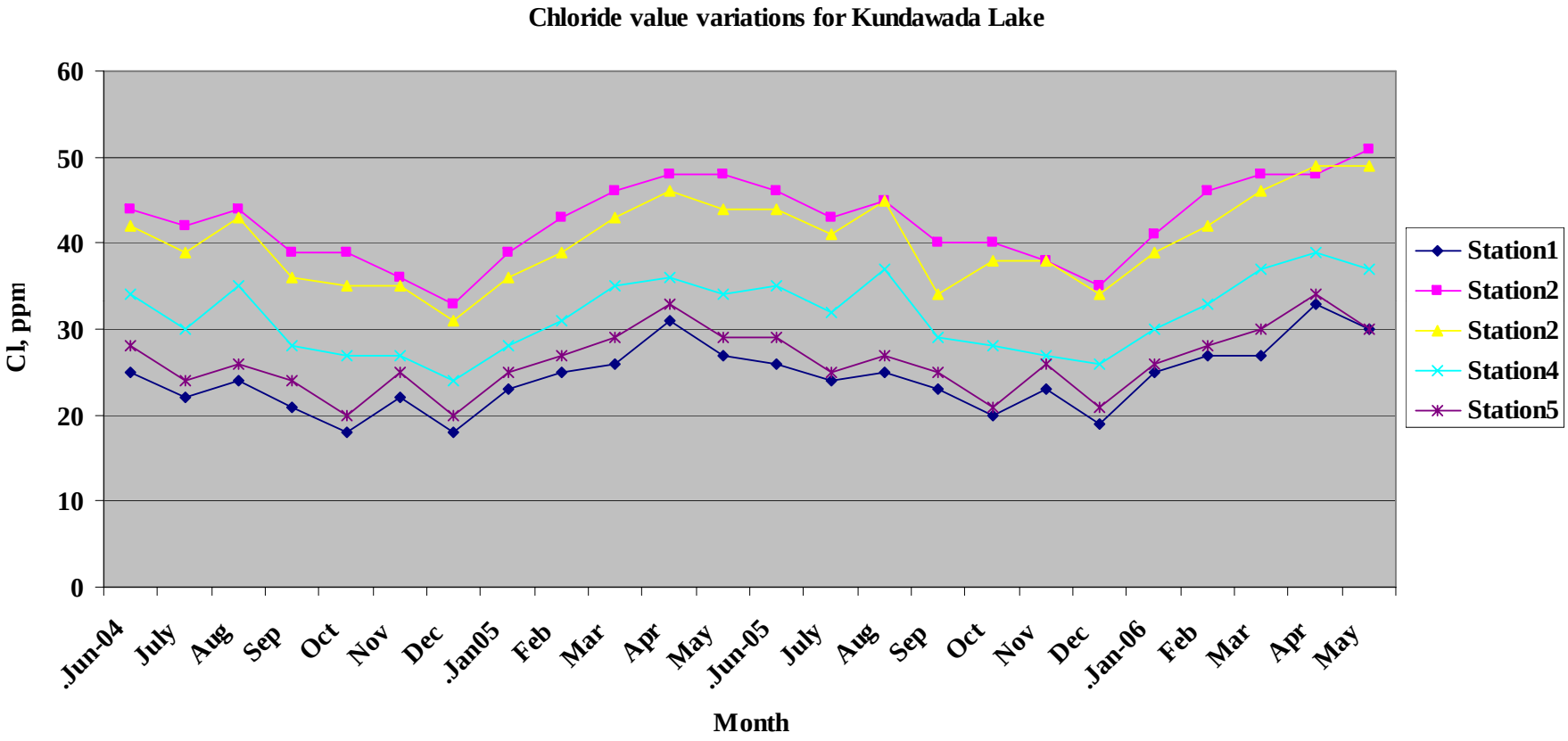
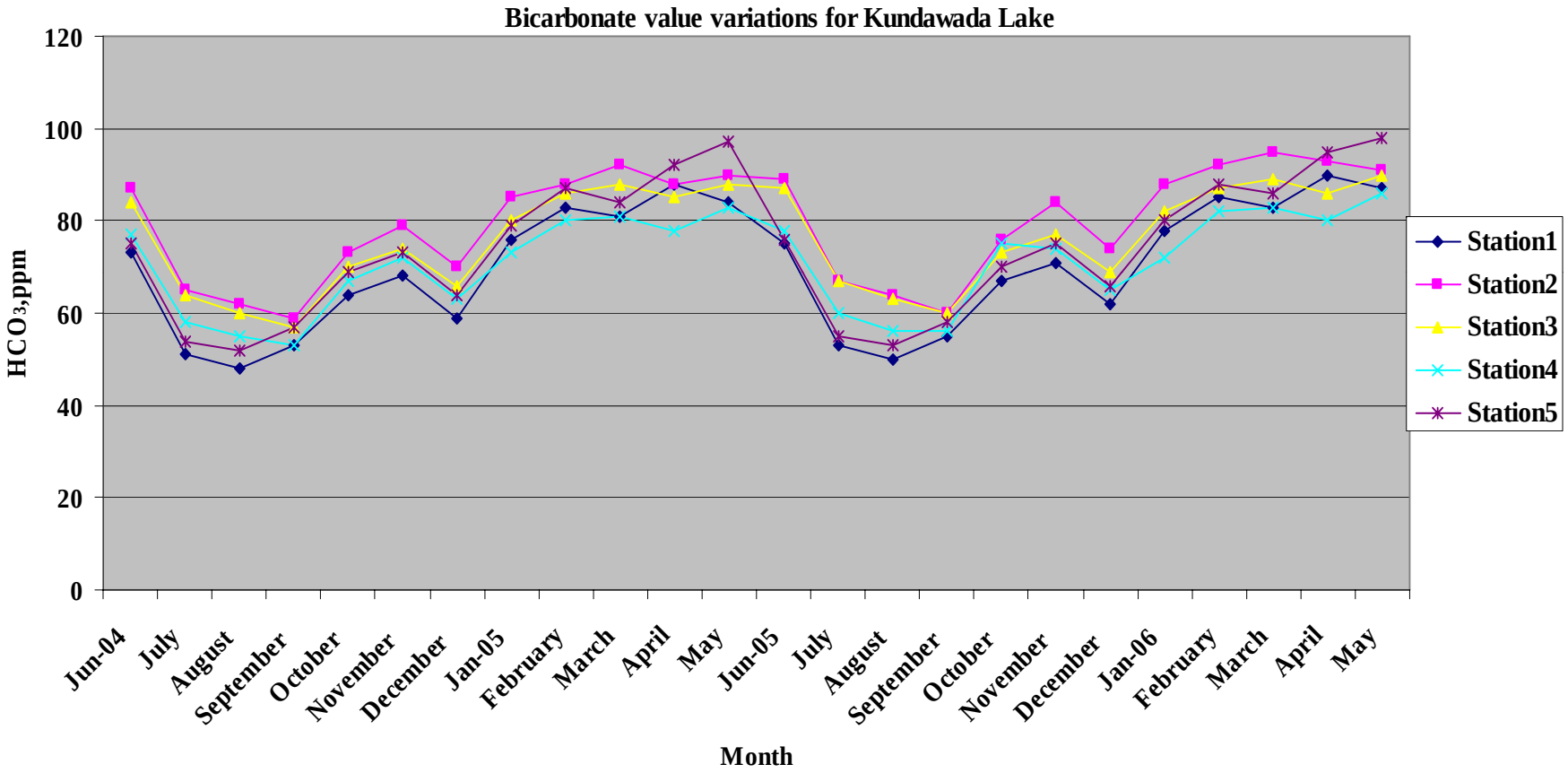
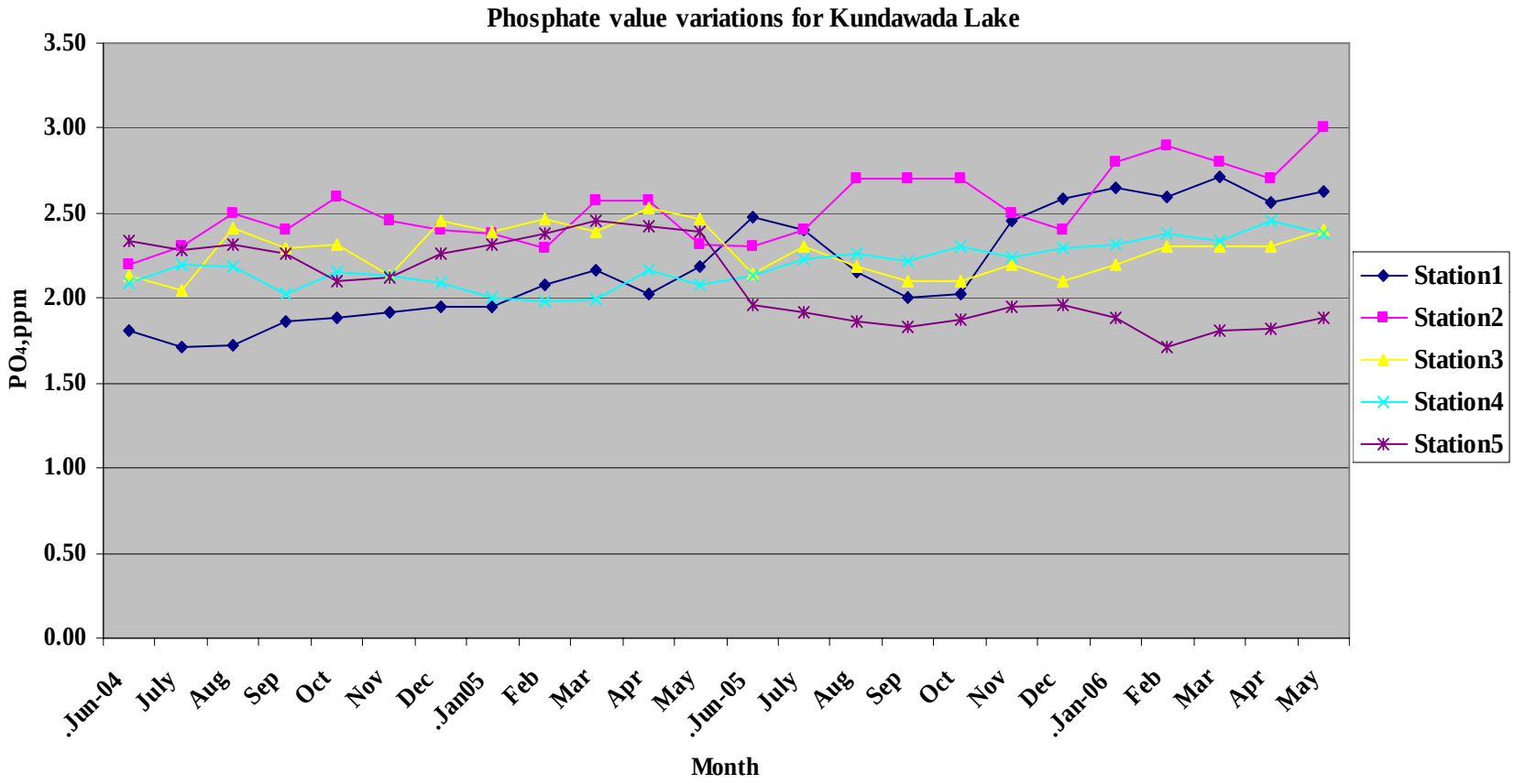
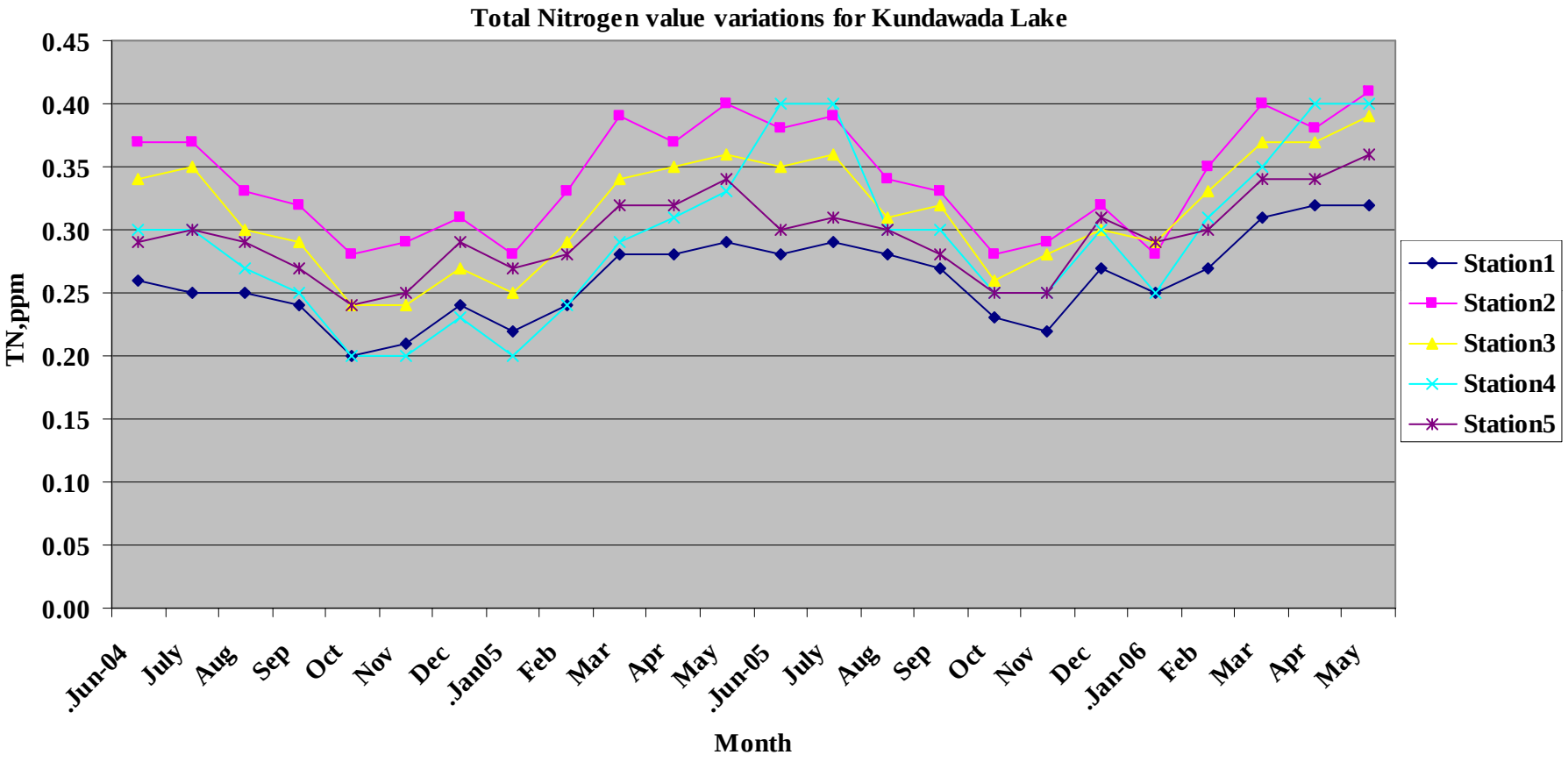

Chloride value variations for Kundawada Lake
Cl, ppm
60
50
40
30
20
10
0
Jun-04
July
Aug
Sep
Oct
Nov
Dec
Jan05
Feb
Mar
Apr
May
Jun-05
July
Aug
Sep
Oct
Nov
Dec
Jan-06
Feb
Mar
Apr
May
Month
Station1
Station2
Station2
Station4
Station5


Bicarbonate value variations for Kundawada Lake
120
100
80
60
40
20
0
HCO3,ppm
Jun-04
July
August
September
October
November
December
Jan-05
February
March
April
May
Jun-05
July
August
September
October
November
December
Jan-06
February
March
April
May
Month
Station1
Station2
Station3
Station4
Station5


Phosphate value variations for Kundawada Lake
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
PO4,ppm
.Jun-04
July
Aug
Sep
Oct
Nov
Dec
.Jan05
Feb
Mar
Apr
May
.Jun-05
July
Aug
Sep
Oct
Nov
Dec
.Jan-06
Feb
Mar
Apr
May
Month
Station1
Station2
Station3
Station4
Station5


Total Nitrogen value variations for Kundawada Lake
TN,ppm
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jun-04
July
Aug
Sep
Oct
Nov
Dec
Jan05
Feb
Mar
Apr
May
Jun-05
July
Aug
Sep
Oct
Nov
Dec
Jan-06
Feb
Mar
Apr
May
Month
Station1
Station2
Station3
Station4
Station5

Biological Parameters
Occurrence of phytoplankton in the Lake under study.

Organisms	Kundawada Lake
Bacillariophyceae	
Amphora Cofformis	+
Navicula hustedtii	++
N. Cryptocephala	-
Synedra ulna	++
Cymbella tumida	+
Gomphonema	+

Melosira granulata	++
Amphora ovalis	+
Epithemia sp.	+
Chlorophyceae	
Scenedesmus quadricauda	+
S. bijugatus	+
Chlorella vulgaris	-
Kirchneriella lunaris	+
Cyanophyceae	
Merismopedia glauca	+

Oscillatoria limosa	+
Phormidium	-
Euglenophyceae	
Trachelomonas chorkoweinsis	+
Phacus indicus	+
Lepocinclis sphaegnophila	-

Note: + = Present - = Absent ++ = Dominant

It is observed in most of the readings that, temperature of water and DO content are inversely proportional to each other. Kundawada lake water was found to be slightly acidic. This may be because of the entry of sewage and agricultural runoff. For Kundawada Lake the conductivity values were relatively high in summer seasons in the study period. However, some researchers in their investigation have noticed that, the electrical conductivity raises during rainy season and showed downward trend in winter season. From the results it shows that the turbidity values are more during monsoon season and less in pre monsoon and post monsoon season.

In natural waters, the total dissolved solids consist mainly of bicarbonates, carbonates, sulphates, chlorides and nitrates and possibly phosphates of calcium, magnesium, sodium and potassium with traces of iron, manganese and other ions. The study showed that TDS values are reported more in summer season than in other two seasons. The results clearly indicate that the DO content in the rainy season in all stations is higher compared with that of pre-monsoon values. On general considerations, a reduction in the content of dissolved oxygen during summer months could be attributed to the higher temperature and increased process of microbial decomposition of organic matter.

In the present investigation it is observed that the BOD values are higher in pre-monsoon season and minimum in monsoon season. The above observations confirm with the observation made by Naidu *et.al* (1990) [10]. It has been consistently noted that the content of dissolved oxygen and BOD are inversely related to each other. Whenever, BOD was found to be more, there was always corresponding decrease in the content of dissolved oxygen. Similar observations are also made by Unni *et.al* (1992) [14]. It has also been observed that BOD has a positive correlation with the pH, temperature and COD.

Season wise, it is observed that, minimum COD values are observed in the monsoon season and maximum values are observed in the pre-monsoon season. It is observed that COD values are higher at station II of Kundawada Lake in all seasons as compared to the other stations, indicating these stations are more polluted due to addition of sewage and agricultural runoff. Mitra (1982) [9], Venkateswaralu *et.al* (1986) [16], Unni *et.al* (1992) [14] are of the opinion that the content of total hardness in fresh water is variable and low. In the present investigation the total hardness value has varied from minimum of 48 to 140 mg/l as CaCO3. In case of alkalinity, the minimum value is recorded in station II and the maximum in station V.

It is observed in the present investigation that the values of alkalinity are higher in pre-monsoon season than that of monsoon season. Many investigators are of the opinion that magnesium was observed always lower than calcium concentration (Kaul *et.al*, 1980 [7]; Birsal *et.al* 1985 [5], Maria Bombowna, 1984 [8], Venkateswaralu *et.al* 1986 [16], Bharati & Krishnamurthy, 1990 [4]; Singh and Singh, 1990 [12] & Unni *et.al* 1992 [14]). The concentration of Calcium and Magnesium in the present study is in conformity of the above investigators. The concentration of calcium observed was always higher than magnesium concentrations. In the present study, sodium was found to be more than the potassium at all stations in all seasons

This is in agreement with Mitra (1982) [9]. Both the cations occurred all along the investigation and they represented higher concentration during summer months. Sulphate and chloride concentration shows marked seasonal variations. Their concentrations were well below the threshold limit of ISI and WHO (250 mg/l for both). Bicarbonates showed the seasonal variations.

Swarup and Singh (1979) [13] observed higher bicarbonate contents in summer months and concluded that it was due to liberation of carbon di-oxide in the process of decomposition of bottom deposits, which possibly resulted in the conversion of soluble carbonates of calcium into soluble bicarbonates. The present investigation also is in conformity with this. The present investigation showed relatively higher values for Phosphate and the reasons for higher phosphate content may be attributable to the wastewater from domestic utilities. Other reason could be the use of phosphate fertilizers in the farming operations carried out in the areas adjoining to the Lake catchment area. Shastry *et.al*. (1970) [11] have reported increase in the concentrations of ammonical nitrogen during rainy reason and decline trend in the summer season. The present investigation also confirms this.

The parameter like Iron, Silica and Fluoride were measured in very little quantity. In case of Biological parameters, the dominance of *Chlorophyceae* in Kundawada Lake might be due to high dissolved contents. Gupta *et al* (2003)[6] have also observed that the green algae prefer water with higher concentration of DO. Monthly variations of *chlorophyceae* showed peak during summer. The decline in phytoplankton density during rainy season appears to be caused by increase in water level. However in the present investigation the *Bacillariophyceae* were abundant during summer months in all the stations studied. This is due to the fact that the *Bacillariophyceae* have the ability to withstand relatively higher temperature ranges for their maximum development.

It is rather very interesting to note that, the water body Kundawada Lake lodged a maximum number of *Euglenophyceae* reaching up to 49010 O/l in the month of October 2005 and reached their minimum population density in the month of January 2005 with 2710 O/l. A total of 3 genera and 3 species of *Cyanophyceae* (blue-green algae) were identified from the present water body and the species diversity includes *Merismopedia glauca, Oscillaria limosa* and *Phormidium*.

Restoration of Lakes
Major Problems of Lakes

- Eutrophication
- Accelerated siltation
- Aquatic plants and weeds growth
- Toxic chemical contamination
- Classic organic pollution
- Acidification to lakes
- Ecological succession.

Schemes of Restoration Lakes
Mixing and Oxygenation process

Many techniques are available for oxygenation of polluted lakes. They include:

- Destratification by mixing the entire water column.
- Hypolimnion aeration.
- Epilimnion mixing.
- Layer aeration
- Speece cone.

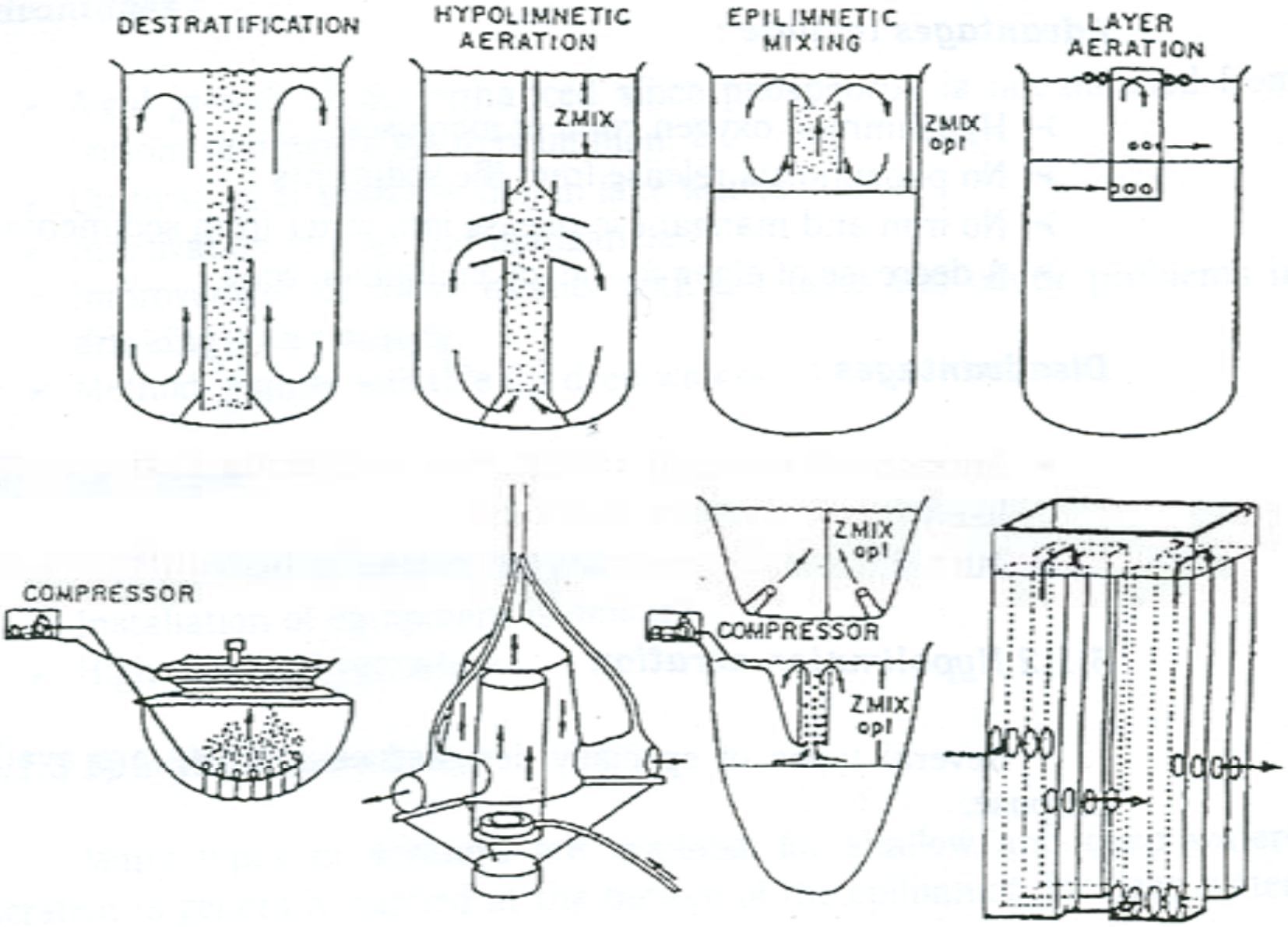
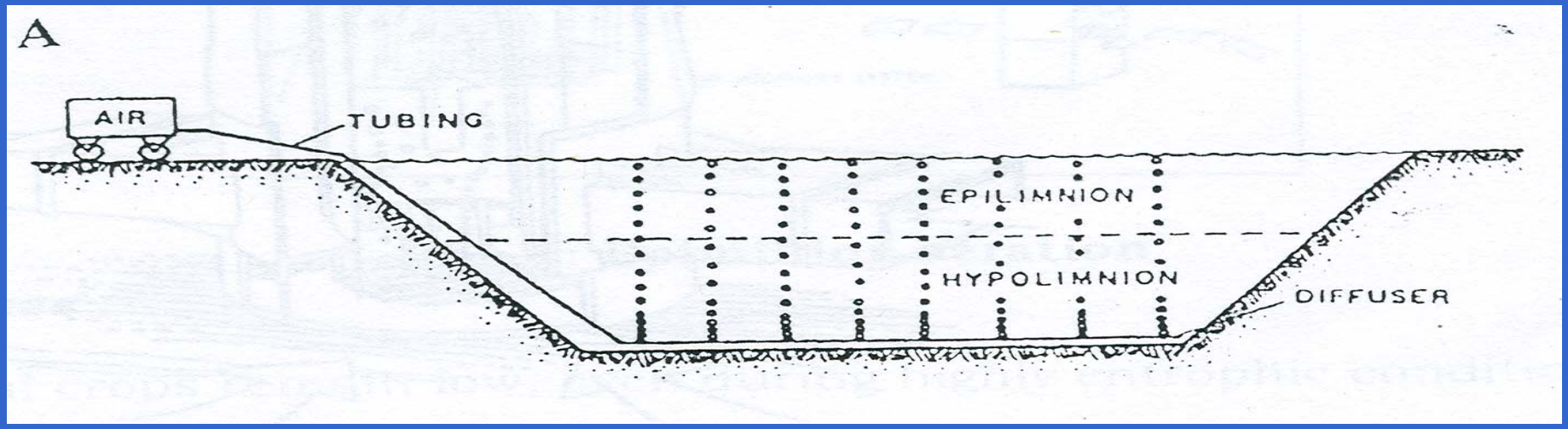


Fig. 1: Different types of aeration processes



Destratification

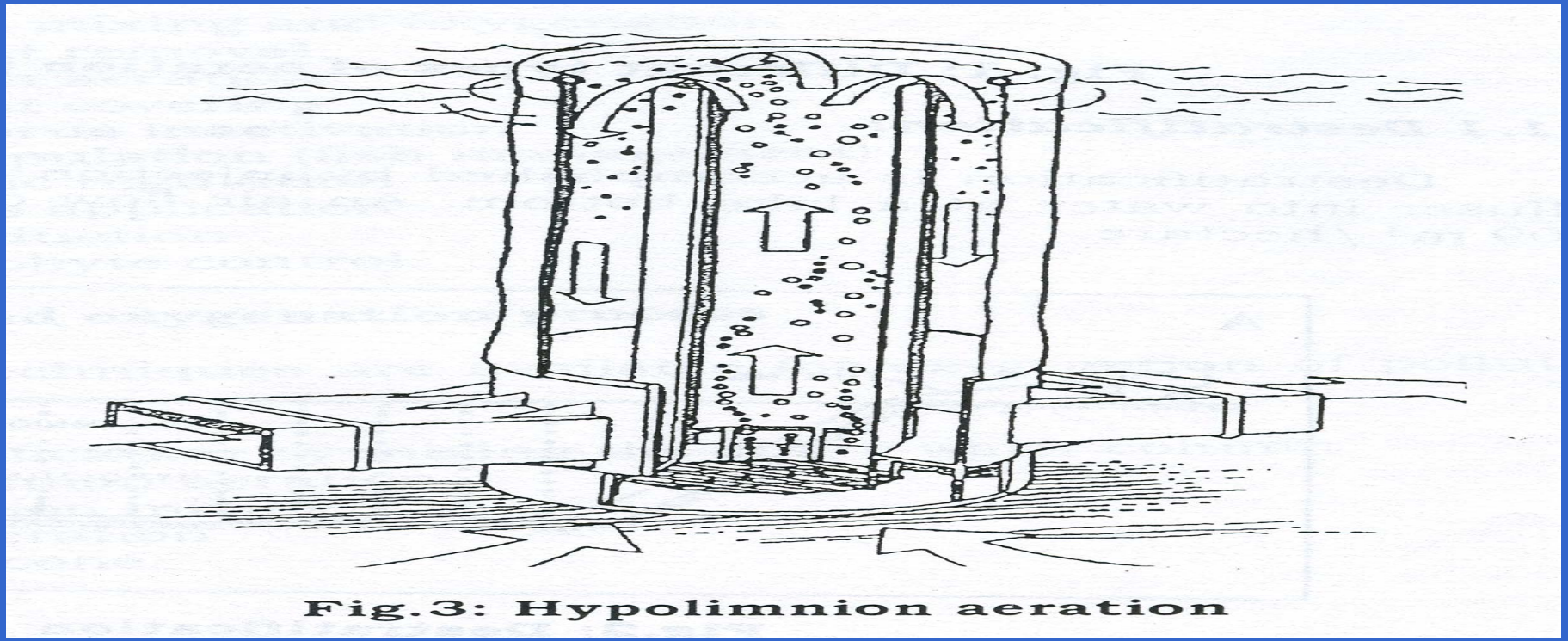
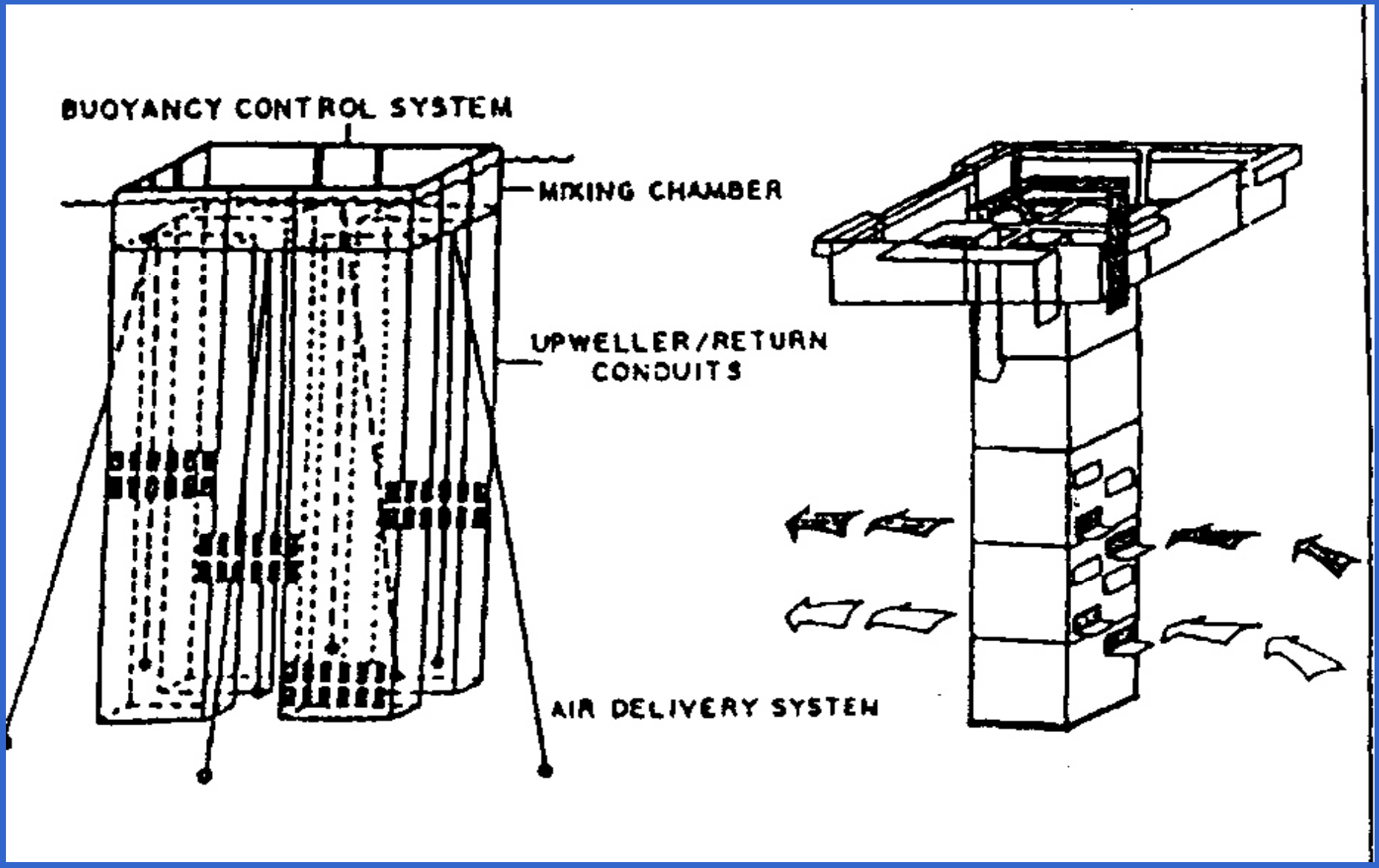
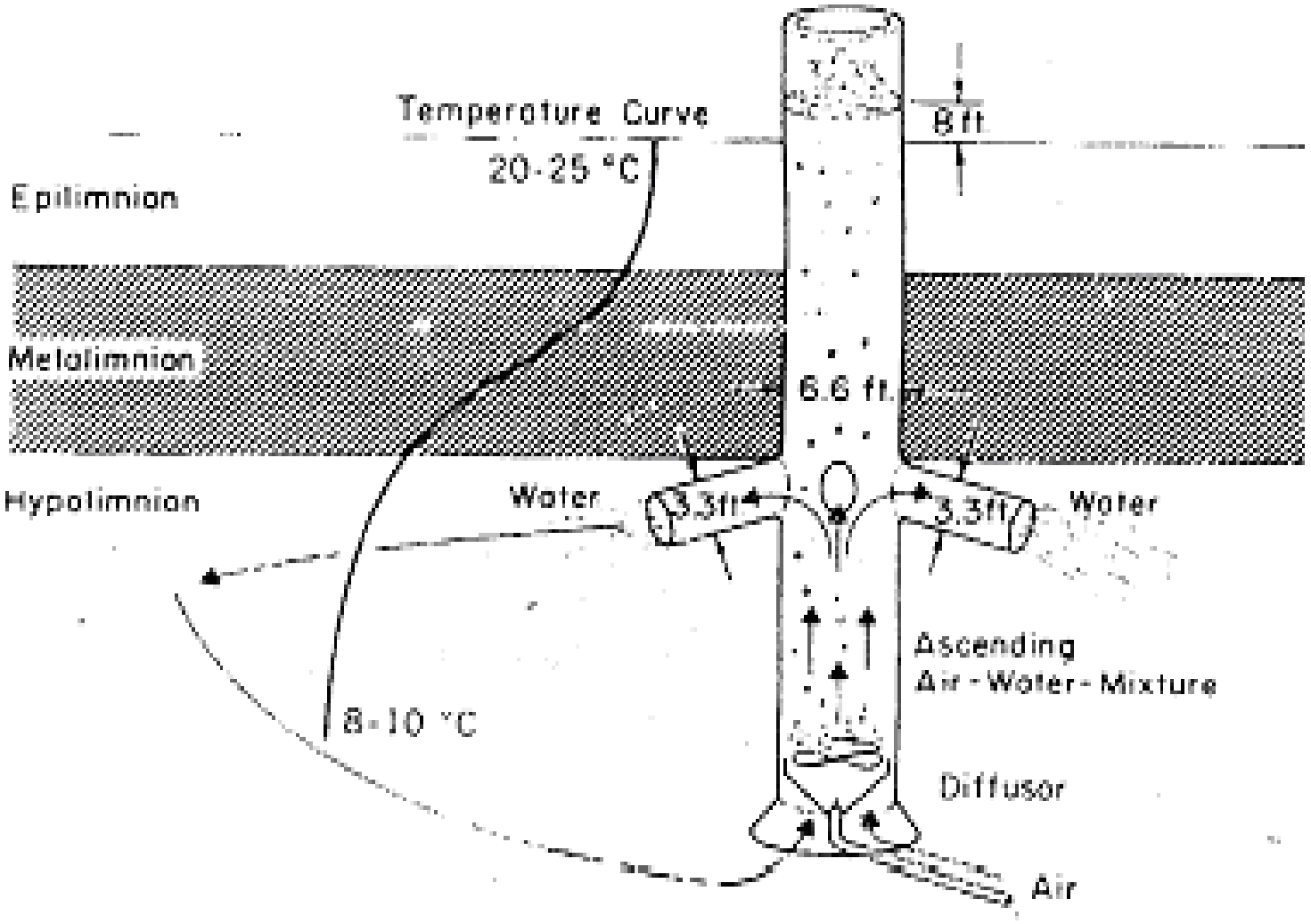


Fig.3: Hypolimnion aeration

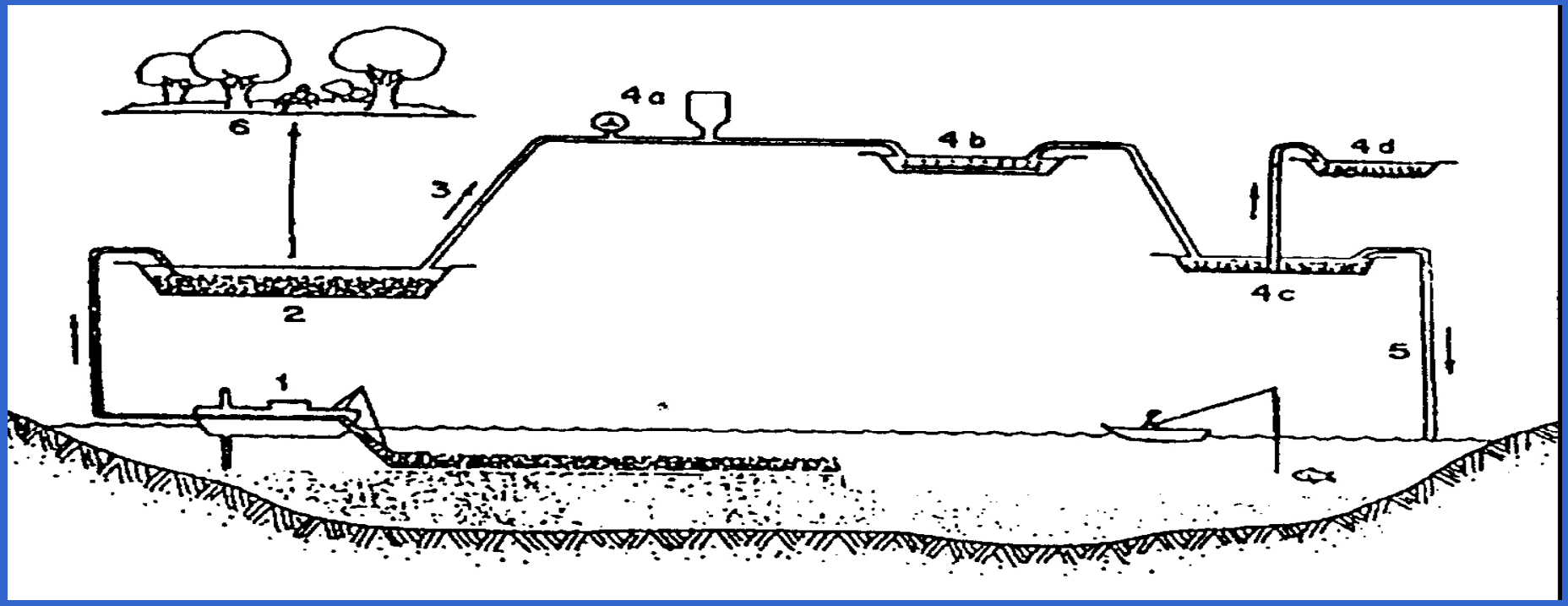


Epimillion aeration

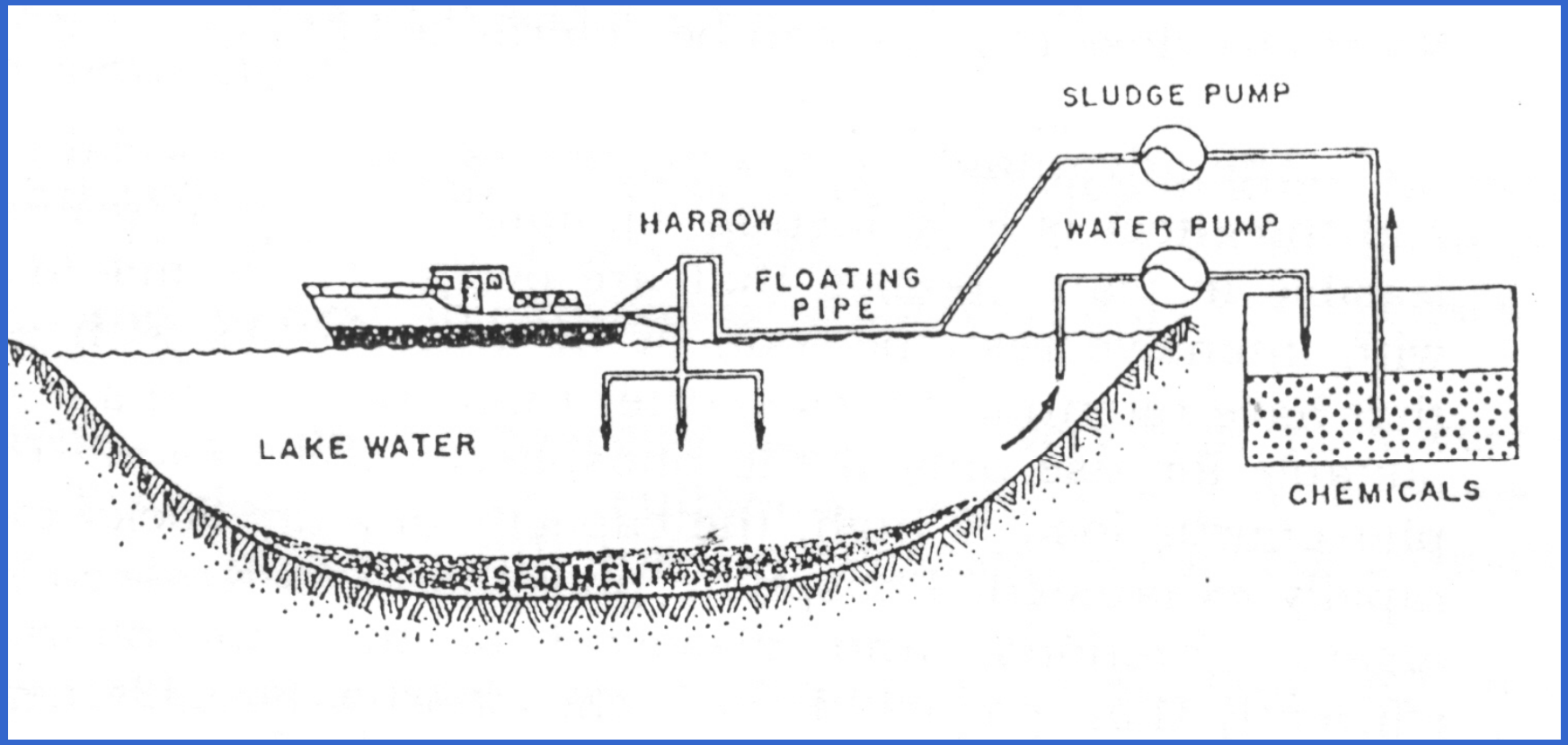

Temperature Curve
20-25 °C
8 ft
Epilimnion
Metalimnion
6.6 ft.
Hypolimnion
Water
3.3ft
3.3ft
Water
Ascending
Air - Water - Mixture
8-10 °C
Diffusor
Air

Speece Cone

Schematic representation of sediment removal.



(1. The bottom mud suction dredger, 2. Settling pond for sediment drying up, 3. Run-off water to the aluminum Sulphate automatic dosing instrument 4a and its aeration basin 4b. The overlying water is returned from the sedimentation basin 4c to the lake through tube 5, while the dried treated sediment is used as fertilizer in agriculture.)



Sediment aeration and oxidation

Sediment capping
In-lake phosphorus inactivation
Biomanipulation
Hydraulic Regulation
Algaecides Application
Macrophyte Control

Restoration of Lakes Investigated in the Present Study

Kundawada Lake

- Laying of conduits by the side of the bund to carry sewage up to the down stream side of the lake to restrict the seepage of sewage in to the lake.
- Removal of the polluted water from the lake.
- Desiltaion work of the entire lake.
- Construction of detention bund along the water spread of the lake.
- Formation of trench all round the bund for diversion of agricultural seepage and runoff.

- Laying of the proper pipe lines for drawing water from Bhadra canal as there is no catchment area available for the inflow of water in to the lake. Bhadra canal is situated on the south side of the lake with a head of 13 m and at a distance of 2.0 KM from the lake.
- Construction of Water treatment plant for drinking water supply.
- Construction of over flow weir to maintain designed quantity of water level.
- Construction of a small island in the center of the lake for recreational purpose.
- Development of greenery all around the bund along with fencing to protect the lake area from encroachments and other activities.

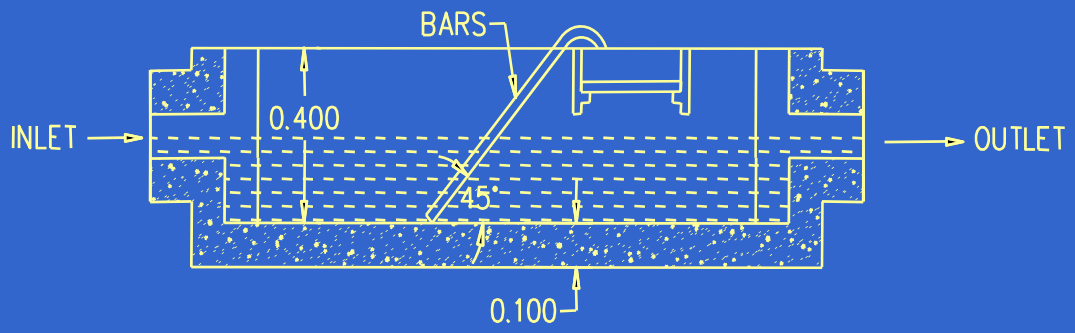
Incorporating all the parameters a detailed sewage treatment scheme for treating the sewage which has been diverted by avoiding entry in to the Kundawada Lake has been proposed. Engineering designs and constructional drawings for all the units are given in detail. Based on this recommendation and study conducted by me a proposal is submitted by Local Corporation Authorities, for the approval from The Lake Development Authority, Govt. of India, for implementation of the project.

Units of Proposed Sewage Treatment Plant

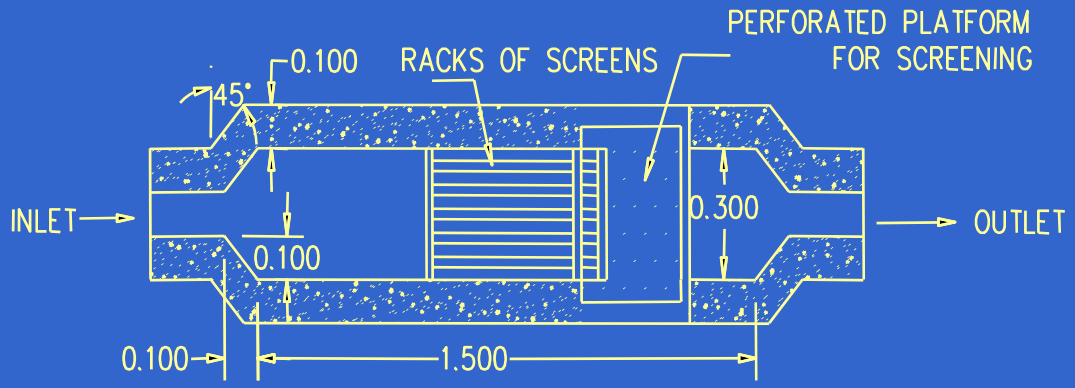
1. Screens
2. Grit Chamber
3. Primary Clarifier
4. Extended Aeration System
5. Sludge Drying Bed

Design Parameters

• Inflow Quantity	12.8 MLD
• Inflow BOD	300 mg/l
• % Removal of BOD in primary treatment	30.0 %
• % Removal of BOD in secondary treatment	90.0 %
• Expected effluent BOD	30.0 mg/l
• Expected suspended solids in effluent BOD	40.0 mg/l

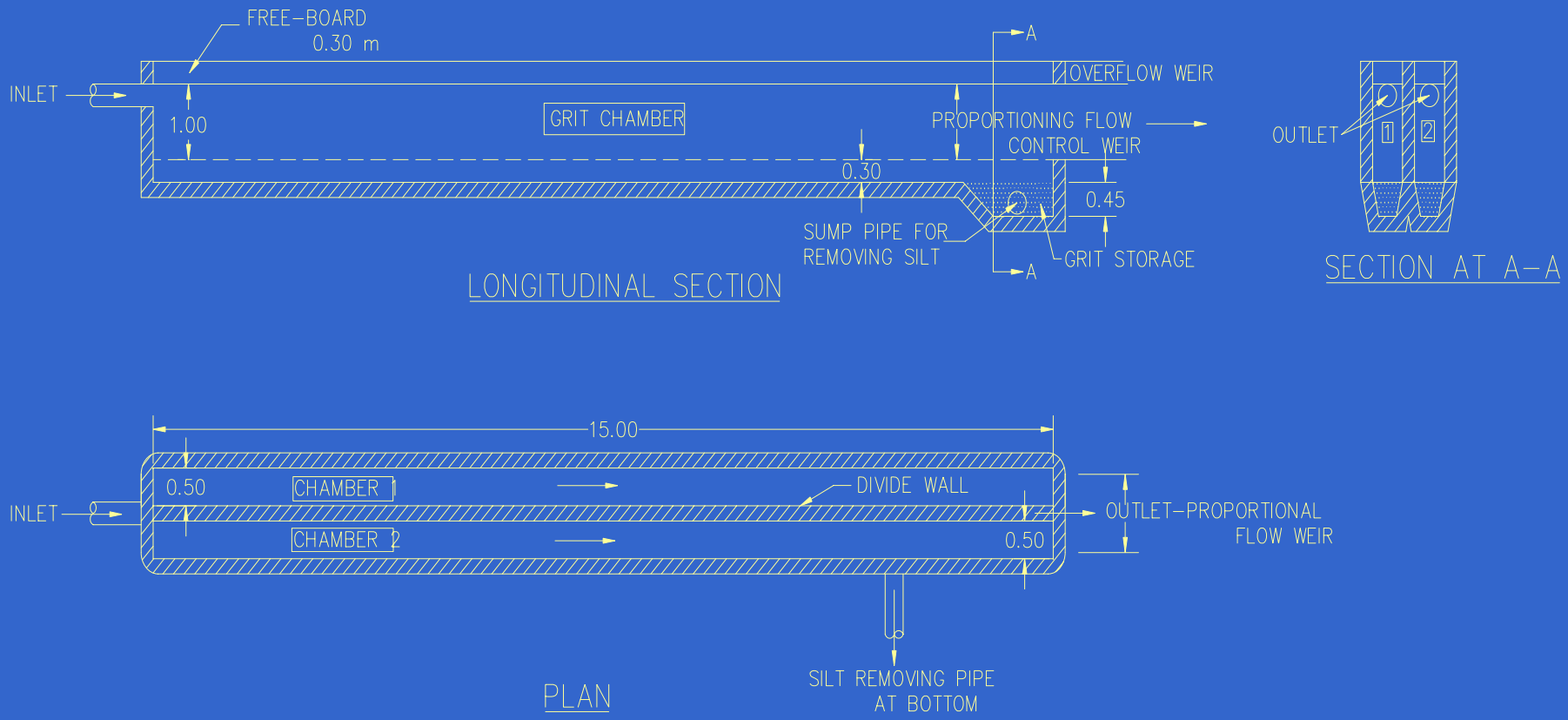


SECTION

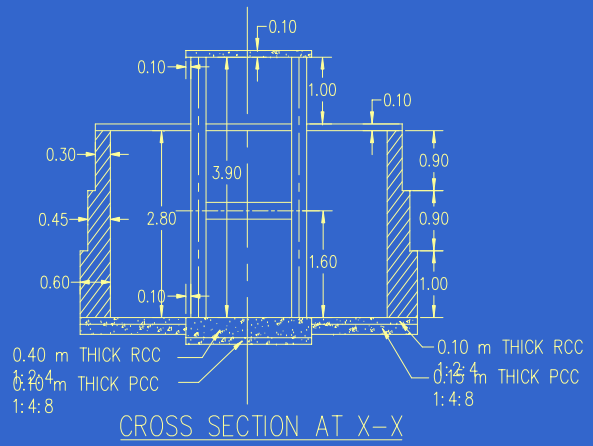


PLAN

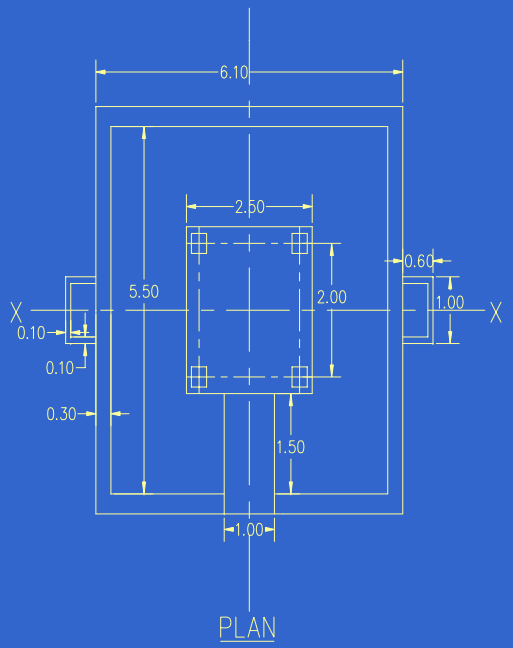
SCREEN CHAMBER



GRIT CHAMBER

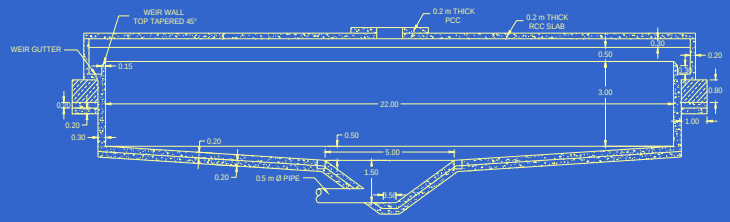


CROSS SECTION AT X–X

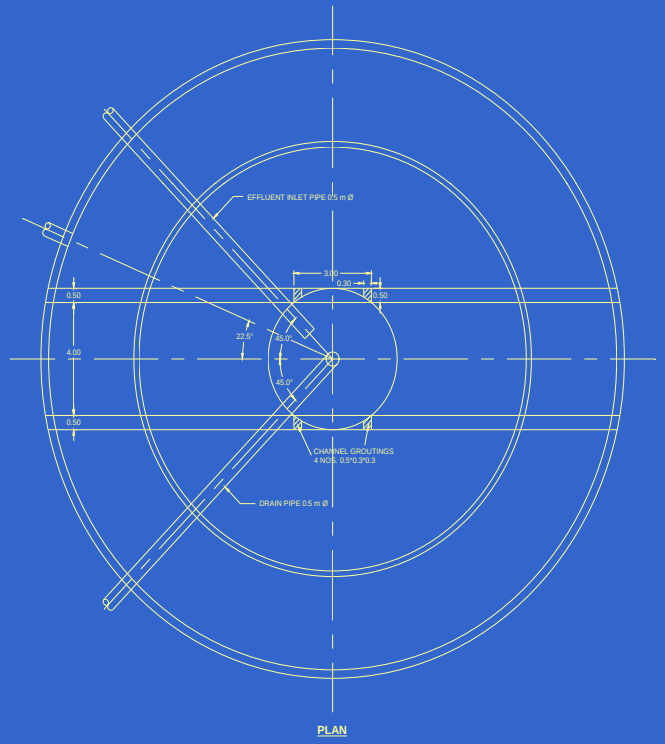


PLAN

AERATION TANK



SECTION



PLAN

CLARIFIER

CLARIFIER

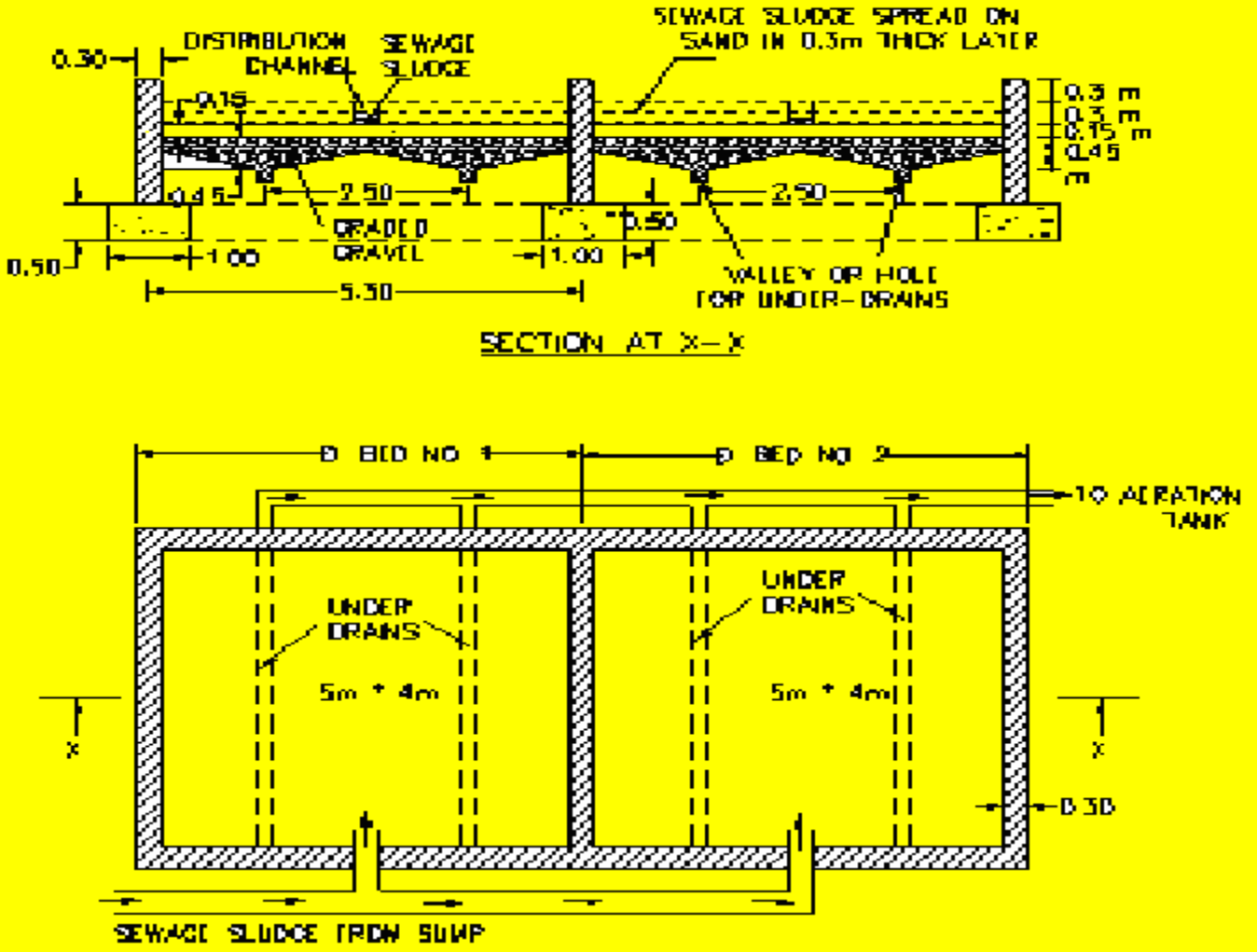


Fig. 5.12 Plan and Section of Sludge Drying Beds

SUMMARY AND CONCLUSIONS

Water quality deterioration precedes environmental degradation. Prevention of water pollution and sustained conservation strategies for surface water bodies are inevitable to overcome various economical and ecological losses. The question of protecting and preserving the surface water bodies is a critical issue in maintaining the quantity and quality of water for multiple uses. It has long been established that the increased population, rapid industrialization, fast urbanization and modern agricultural practices (use of chemical fertilizers and biocides) are the four major environmental factors endangering the surface water bodies all over the world.

As a consequence of this, the water bodies have been put under severe ecological stress and are being threatened. This is due to dumping of solid and liquid wastes into the Lake ecosystem. It is very much true in case of Kundawada Lake, studied in the present investigation.

With this background, the present work was undertaken between May 2004 to April 2006 to study the physico-chemical and biological characteristics, pertaining to the water of selected Lake. Different methods of restoration of Lakes in general and specific restoration methods for the Lake under study have been outlined.

In addition to this detailed technical design of the sewage treatment plant by the side of Kundawada Lake along with the constructional drawings of the different units, has been included to treat the sewage of Davangere city.

Water samples were collected at monthly intervals and analyzed for pH, DO, BOD, COD, Ca, Mg, Sulphate-, Phosphate, Nitrogen, Na, K, EC, turbidity and other parameters by following standard procedures. Temperature and pH were recorded at the spot of collection and remaining parameters were analyzed in the laboratory.

Periodicity and distribution of phytoplankton were taken into consideration under biological parameters by qualitative and quantitative estimation. Moreover, preliminary observation in diversity of zooplankton, mycoflora and aquatic machrophytes has been carried out.

Recommendations

The discharge of domestic and agricultural waste water into this water body should be avoided or the waste water should be properly treated before discharge to reduce the pollution load in the water bodies.

Indiscriminate use of fertilizers in catchment area should be controlled by giving proper guidance to the farmers through mass media programmes.

The quality of the water body should be regularly monitored to formulate protective measures to control the pollution.

Suitable sewage treatment plants have to be designed for all the municipal wastes and schemes are to be strictly implemented.

Scope for Further Work

Pesticide analysis should be done for both water and sediment.

The influence of metal ion pollution on flora and fauna of the Lake ecosystem can be investigated in order to arrive at the biomagnification and bioaccumulation rates of heavy metals.

Continuous monitoring of water quality of this Lake need to be established by pollution control agencies. This provides substantial information in the future trends of water quality changes.

Thank You