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Assessment of physico-chemical parameters of limestone mines water near J.P. cement plant Rewa District M.P. India

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ABSTRACT: *The present paper deals with the water source for existing Jaypee Bela and Naubasta mines is the respective mines reservoirs that have been created by filling up rain water in the mined out areas in the existing mines. The total water storage capacity of Jaypee Bela and Naubasta mines reservoirs is approximately 7 lac KL and 25 Lac Kl respectively which cater to the needs of mine operation. Water requirement at the mines is mainly for dust suppression, other mine operations such washing of machines, cooling of machines, domestic use of labour colonies and hut-mates, and green development purposes. The total water requirement at the existing Bela mines is about 240 m^3 /d which at Naubasta mines is 250 m^3/d. This includes water for domestic consumption.*

KEYWORDS: *Jaypee Bela; Naubasta; Madhya Pradesh India*

I. INTRODUCTION

The environmental pollution as a result of Cement industry could be defined as an undesirable process that is responsible to pollute water, air and land through its various activities, right from the mining activity of the raw material (limestone, dolomite etc.) to its crushing, grinding and other associated processes in cement plant.

The extensive quarrying of raw material not only adds various pollutants/contaminates to the environment, but disturbs the total ecosystem of the area. The gases and dust from the cement plant is in no way less hazardous compared to other industries.

The mining of raw materials for cement in India is still more or less a simi mechanized, using equipment like bulldozers, shoawls dumpers etc. for various operations. The open cast pits (reservoirs) formed at Bela and Naubasta limestone mining area are not very well planned and seve as receptacles of rain water and drainage water from surrounding up-land.

The major environmental problems (Nandusetar 1991) related to mining are :

- Pollution of ground water.
- Pollution of surface water
- Loss of productive land due to open cast/under ground mining.
- Loss of land and Property by surface and water ground minfe fire.
- loss of land and property by surface subsidence.
- Loss of property and injuries caused by rocks and ground vibrations during blasting.
- Air pollution.
- Deforestation.
- Erosion of top soil.
- Leaching effect from overburden.
- Disappearance of fauna and flora.
- Socio economic aspects.

A number of studies are available on the impact of Cement dust emission on various environmental components (Borka 1980, Agrawal et al 1988, Agrawal and Agrawal 1989, Kamara Swamy 1991, Sharma 2008).

Cement industry is a continuous source of Cement dust and their constituent gases such as SO_2, CO_2, CO, and SiO_2 adversely affect the drinking water resources like wells, ponds and mine pits. The presence of total solids in the form of salts of Ca, Na, K, Mg, Al as hydroxides sulphates and silicates leads to hardness of water which causes gastro intestinal disorders which have been found as quite common in the area (Mishra and Tiwari 1986).

Physico-Chemical Characteristics :

Several studies have been conducted to undersatnad the physical and chemical properties of ponds and reservoirs in differenct locations in India (Throat and Musarrat Sultana 2000, Mohanraj et al 2000, Yogesh, Shastri and Pendse 2001). Shrivastava et al 2003 studied the physico-chemical properties of various water bodies in and around Jaipur.

Water quality deterioration in reservoirs usually comes from excessive nutrient inputs, eutrophication, acidification, heavy metal contamination, organic pollution and obnoxious fishing practices. The use of physico-chemical properties of water to assess properties of water quality gives a good impression of the status, productivity and sustainability of such water reservoirs. (Iwama et al 2000). One major goal of surface water quality data collection may be the estimation of megnitude of changes in concentration of various constituents. (Giljanovic 2005, Anand et al 2006. Krishnan et al 2007).

Water Scenario :

Water is the most important ingredient sustaining many processes of mining and Cement manufacturing units. Water intended for human. consumption should be safe and wholesome i.e. free from pathogenic agents and harmful chemicals, pleasant to taste and usable for domestic purpose. Urban and rural India depends heavily upon various types of water bodies to meet its daily requirement of water. This is a highly worrying fact as, the role of the ponds in urban and peri urban milieu is multifaceted. It just is not a pool of water, as this pool may not be considered as playing a very major significant role of social, ecological and civic importance.

The water source for existing Jaypee Bela and Naubasta mines is the respective mines reservoirs that have been created by filling up rain water in the mined out areas in the existing mines. The total water storage capacity of Jaypee Bela and Naubasta mines reservoirs is approximately 7 lac KL and 25 Lac Kl respectively which cater to the needs of mine operation. Water requirement at the mines is mainly for dust suppression, other mine operations such washing of machines, cooling of machines, domestic use of labour colonies and hut-mates, and green development purposes. The total water requirement at the existing Bela mines is about 240 m^3 /d which at Naubasta mines is 250 m^3/d. This includes water for domestic consumption.

The water sources in both mine areas are not existing as one unit. Small pudder are scattered and created as per the practice of mining done in the area. First the area of high grade limestone are worked out first and subsequently as the limestone quality deteriorated, the mining operations were taken up gradually thus the mine water pits are scattered haphazarelly. Such ponds are generally described as a water body of a smaller size, mostly man made (mined resulted). The role as controllers of microclimate can not be ignored. Local natural life (aquatic avifauna and terrestrial) sustains around these water bodies. Ponds and the surrounding are one of the most important protectors of biodiversity.

One function of ponds is that they serve as receptors for rain water inflows and help in maintaining local ground water levels. Thus these water bodies are a special components in water use management. In the present study, the attention have been mostly concentrated on physico chemical characteristies.

a) Identification of 4 such bodies of sufficient size- two each at Bela and Naubasta area.
b) To study the physico-chemical characteristic of the water in these mine-reservoir.
c) Gradation of water quality.

II. MATERIALS AND METHODS

Study site : (Location & Surroundings)

The present mining sites at Bela and Naubasta are about 5 kms apart from each other. These sites are approximately at a distance of 15 to to 18 Km from Rewa which is the district head quater. The coordinates and expanse of mines ranges from approximately N $24^0$30' to N 24^0, 38' and E 81^0 08' to 81^0 13' .

Bela mines are located about 4 Km, white Naubasta mines are about 8 km from the NH 7 connecting Allahabad and Jabalpur. The nearest major railway station is Rewa connecting Satna. This railway tract runs at a distance of 5 kms on the south of the Naubasta mining sites.

These are no ecologically sensitive areas, historically important places, environments etc. within 10 kms of the site.

The lime stone deposits belong to the Bhander area of the upper Vindhyan system and belong to the Nagod limestone formations. A generalized succession of the formations can be seen as follows : Soil and Talus cover, shale upper grey limestone (UGL) Middle shale (MSH) Nodular Shale (NDS), Lower Grey limestone (LGL), Cherty Limestone (CHL), and Magnesium Limestone (MGL), of these, the UGL and LGL are two main limestone bands considered for exploration in the area. (Geology Deptt. Govt. Model Science College Rewa).

The working depth in the mining lease areas varied from 5 m to as much as 45 m because of the topographical and structural behaviour of deposit.

Selection of reservoirs for physics chemical characterization :

Two reservoirs (2 each at Bela and Naubasta) were identified for the sampling of water. For identification purpose they are named as Bela A and Bela B and Naubasta A and Naubasta B.

Morphomatric Characterization

Bela A :

The contour of Bela A reservoir almost appear to as rectangular in shape. The breadth extends to 20 meters while the length extends to approximately 40 m. The depth from the border to Centre varied from 0.5 m to 10 meter. The pond is of perennial nature, drying only in hot summer months of April, May and a part of June.

Bela B

The second pond Bela B appear undulating. The breadth ranged from 2 m to 8 m and the length varied from 10m to 12 meters. The depth from the water ranged from 0.5 m to 8 m. During hot summer months only a small puddle remains and most of the body gets dried up.

Naubasta A

At Naubasta A the reservoir morphology affears circular. The total area amounts to approximately 1.5 hectare . The depth in the centre is recorded as 10 m.

Naubasta B

Naubasta B water body appear rectangular the length varied from 10 m to 15 m and breadth 5 m to 8 m. The deepest point in the centre is recorded as 12 meter.

Water Analysis

samples were taken regularly at an interval of 30 days. The sampling was done between 9 AM to 11 AM. The universal accepted methods of analysis were applied –samples were taken to laboratory in one to two litre sampling plastic bottles for the analysis : The analysis of various parameters had been carried out as per internationally accepted methods (APHA 1998, A.P. Adoni 1985, R.K. Trivedy and P.K. Goal 1986). Various parameters studied were as follows:

1.Transparency 2. pH 3.Conductivity (m^5.cm) 4.Dissolved Oxygen (mg^{-1}) 5.BOD (mg^{-1}) 6. Free CO_2 (mg^{-1}) 7. Total Solids (mg^{-1})8. TDS (mg^{-1}) 9. Alkalinity (mg^{-1}) 10. Chloride (mg^{-1})11.Sulphide (mg^{-1})12.Total Hardness (mg^{-1})

Transparency is inversely propositional to the turbidity of water, which in turn is directly proportional to the amount of suspended organic and inorganic matters. When secchi-dise is gradually lowered in water, it remains visible in the euphatic zone, only to that lower level light is about 15% of the radiation at the surface. This is the measure of Transparency.

pH measures the hydrogen ion concentration in the water. It is measured on a log scale and equals to negative log 10 of hydrogen ion concentration.

pH was measured directly by the pH meter.

Conductivity denotes the capacity of a substance to conduct the electric current conductivity was recorded using the direct reading conductivity meter.

The presence of dissolved oxygen is essential to maintain the higher form of biological life and to keep the proper balance of various poulations making the water body healthy. The chemical and biochemical process undergoing in a water body are largely dependent upon the presence of oxygen.

Dissolved oxygen was determined by Winkler's method with Azide modification. The water sample were collected in BOD bottles (300 ml) without bubbling and immediately fixed by the addition of 1 ml of magnenous sulphate reagent followed by alkaline potassium iodide reagent respectively. After through mixing of the reagent in sample, precipitate formed was allowed to settle down.

For qualitative estimation 1 ml of concentratied H_2SO_4 has added to dissolve the brown precipitate. 50 ml of this solution was transperred to a conical flask and tritrate against 0.025 N solution of Sodium thio-sulphate ($Na_2S_2O_3$) tritrate up to disappearance of blue colour by using starch as indicator.

The dissolved oxygen content was calculated by using the following formula – DO in mg/l = ml of titrate N x 8x 1000 ml of sample.

Free CO_2 was estimated by adding 2 drops of phenolphthalein indicator to 50 ml of water sample. If pink colour develops than free CO_2 is absent and if solution remains colour less, then it is titrated to slight pink end point.

$$\text{Free } CO_2 \text{ (mg/l) - } \frac{\text{ml of tritrate x 1000}}{\text{ml of sample}}$$

BOD was deteromined by Winkler's method (APHA 1998), two BOD bottles, one bottle was immediately fixed for its initial dissolved oxygen content. dissolved oxygen content. the other bottle was incubated at 27^0C for three days. After incubation, the dissolved oxygen content of second bottle was analyzed and was considered as final dissolved oxygen.

BOD mg/l = D_1-D_3
Where D_1 = Initial D.O. in the sample
D_3 = After three days.

Total solids is the measure of all kinds of solids i.e. suspended dissolved and volalite solids. total solids can be determined as the residne left after evaporation at 103^0C to 105^0C of the unfiltered sample. It consists of two parts : total suspended solids (TSS) and Total dissolved solids (TDS). For TS A clean beaker (400 ml capacity) was taken and dried at 103 to 105 ^{0}C for 1 hour. The beaker was cooled in desiccator. Beaker was weigthed immediately before use. The initial weigth was noted in mag. About 250-300 ml unfiltered well mixed sample was put in it and beaker was put in hot air oven at 103 to 105^0C for 2-hrs to dryness. Beaker was cooled in desiccator and final weight was taken in mg. Cycle of drying. Cooling, desiccating and weighting is repeated until a constant weight is less than 4% of previous weight or 0.5 mg. which ever is less.

Where Wi = Initial weight in mg.
Wf = Final Weight in mg.
V = Volume of Sample.

A large number of solids are found dissolved in natural waters, the common ones are carbonates, bicarbonates, chlorides, sulphates, phosphates, and nitrates of calcium, magnesium, sodium, potassium, iron, magnesium etc. In other words, TDS is simply the sum of the cations and anions concentration expressed in mg^{-1}.

$$\text{Total Solids (TS)}mg^{1}\ \frac{W_f\ - W_i x\, 1000}{V}$$

A high content of dissolved solids elevates the density of water, influences Osmo regulation of fresh water organisms, reduces solubility of gases (like oxygen) and reduces utility of water for drinking irrigation and industrial purposes.

A beaker was dried at 103-105^0C, cooled in a desiccator and initial weight was noted About 100 ml to 250 ml of sample was filtered through filtered through filter paper (Whatman No. 41) and filtrate was teken in the beaker. Sample was evaporated, in a hot
air oven at 180 $\pm 2^0$C and after the whole water was evaporated. the beaker was collect in a desiccators and final weight was taken.

$$\text{Total Dissolved (TDS)}mg^{1}\ \frac{W_f\ - W_i x\, 1000x1000}{V}$$

Where W_i = Initial weight in (g).
W_f = Final Weight in (g).
V = Volume of Sample.

Alkalinity is a measure of the water ability to absorb H^+ without significant pH change. That is, alkalinity is a measure of buffering capacity of water. The alkalinity of natural or treated water is normally due to the presence of biocarbonate, Carbonate and hydroxide compounds of calcium, magnesium, sodium and potassium.

Alkalinity was estimated by titrating sample with 0.02 N H_2SO_4 first to pH 803 using phenolphthalein as indicator and further to ph 4-5 with methyl orange indicator. The value obtained in the first case is phenolphthalein alkalinity (PA) and in second case is total alkalinity (TA).

$$\text{PA (As } CaCO_3)mg^{-1}\ \frac{AxN\ x\, 1000\ x500}{\text{ml of the Sample}}$$

$$\text{TA (As } CaCO_3)mg^{-1}\ \frac{BxN\ x\, 1000\, x500}{\text{ml of the Sample}}$$

Where
A = ml of standard acid need with phenolphthalein
B= ml of standard acid used with phenolphthalein and methyl orange

Chloride was determined by titration against silver nitrate using potassium chromate as indicator. To a conical flask containing 50 ml sample, 5% $K_2Cr_2O_4$ solution was added and the contents here titrated against standaridzed aG no_3 until the appearance of red tinge. Chloride was calculated as follows.

$$\text{Chloride mg}^{-1} \frac{(A - B) \text{ x N x 35.3 x 1000}}{\text{ml of the Sample}}$$

Where : A = ml of titrant used for sample
B= ml of titrant used for blank
N= Normality of Ag NO_3

An amount of iodine solution was taken and solution was made to 200 ml with distilled water tow ml of 6N HCl was added and 200 ml sample was pipet4ted into flask. The content was titrated with Na_2 S_2O_3 Solution adding few drops of starch solution. The end point was indicated by the disappearance of blue colour.

$$\text{Sulphide } (S^{2-}) \text{ mg}^{-1} \frac{(AxB) - (CxD) \text{ N x 16 x 1000}}{\text{ml of the Sample}}$$

Where A= ml of iodine solution
B = Normality of iodine solution
C= ml of $Na_2S_2O_3$ Solution
D= Normality of Na_2 S_2O_3 Solution

Hardness is defined as the concentration of multivalent metallic cations in solution. Total hardness is determined by EDTA titrimetric method. In alkaline Condition EDTA react with Calcium and magnesium ions to form a soluble chalated complex and the completion of reaction is indicated by colour change of indicator Erichrome black T from wine red to blue. It is expressed in terms of Calcium carbonate.

$$Ca^{2+} + H_2Y_2^{2-} \longrightarrow CaY^{2-} + 2H^+$$
(EDTA)
$$Mg^{2+} + H_2Y_2^{2-} \longrightarrow MgY^{2-} + 2H^+$$
$$MgD^- + H_2Y_2^{2-} \longrightarrow MgY^{2-} + 2HD^- + H^+$$
(Wine red) (Blue)

For hardness estimation25 ml sample was diluted to 50 ml with distilled water and to it 1 ml of alkaline buffer solution and 2 drops of Erichrome black was added. It was then titrated with 0.01 m EDTA till wine red colour changes to blue. Hardness is calculated as follows :

$$\text{Hardness (as } CaCO_3) \text{ mg}^{-1} \frac{\text{AxBx 1000}}{\text{ml of the Sample}}$$

Where A = ml of EDTA used for sample
B = mg of $CaCO_3$ equipvalent to ml EDTA titrant.

Observations & Discussion

Four water resourvoirs created after limestone mining sites near Jaypee Rewa (M.P.) Were selected for six months study from Sept. 2012 to March 2013. Of the four two are located at Bela and two are at Naubasta. The monthly mean data of all 12 parameters are presented in tables 4.1 and 4.2. Minimum and Maximum values are shown as below :

Suspended particulate matter, dissolved solids and the use of water bodies by humans, Cattles and Machines for pumping water to fill the tankers- all churn the water through out the day. The readings for transparency however taken in the early morning hours have shown that the water is comparatively transparent. The value of minimum transparency was recorded as 35.60 cm.in Oct 2012 at Bela A while the maximum value were recorded as 51.00 cm.

In Bela B, the minimum transparency value had been found as 37.45 cm in the month of October 2012 while the maximum value had been 52.25 cm in December 2012. In Naubasta A, the minimum transparency value was 22.53 cm in Sept 2012 while the maximum was recorded as 52.10 cm in March 2013. In Naubasta B, the minimum value had been 25.10 cm in Sept 2012 while the maximum transparency had been found as 48.10 cm in March 2013.

Transparency measures the light penetrating through the water body. Clear water during winter months allow photosynthesis to occur. Since reading for transparency had not been recorded in rainy season which is the high time when drains bring soil and dust particles to water reservoir and make in less transparent. Similar observations were recorded by Kataria et al (1995) and Shrivastava (2013)

The pH is a very important factor in influencing aquatic productivity. According to Swingle (1961), if waters are more acidic than pH 6.5 or more alkaline than 9.5 for prolonged periods, growth of fishes diminish. In general , water pH is low during monsoon due to heavy load of alkaline substences. Some of the studies of small ponds have a range of pH extending between 6.6 -9.0.

In Bela A, the value of minimum pH were recorded in Dec. 2012 (pH 7.60) while maximum value had been 8.15 in March 8.15.

In Bela the minimum pH were found as 7.60 in Sept. 2012 and the maximum pH had been observed as 8.15 in March 2013.

In Naubasta A reservoir the minimum pH was recorded in December 2012 as 7.63 while the maximum had been pound in February 2013 as 8.25.

Conductivity is the capacity of water to conduct electric current which varies both with the number and types of ions. Most dissolved inorganic substances in water are in the ionized form and hence contribute to conductance.

At Bela A, the value of minimum conductivity was recorded as 251.15 μ mhos in March 13 while the maximum had been in Sept 12 as 350.67 μ mhos. At Bela B, there were no significant difference in the values except that minimum conductivity value was recorded in Dec. 72 while maximum of 348.10 μ mhos was found in October 2012.

In Naubasta A reservoir a the minimum and maximum values ranged between 232.10 (January 2013) . The conductivtiy values in Naubasta B samples ranged between 236.00 Sept 2012 to 359.33 (December 2012).

Conductivity is highly dependent on temperature and therefore is reported normally at 25^0C to maintain comparability of data seasonal variations in the conductivity may be due to the increase concentration of salt because of discharge effluent and organic matter.

In water samples of Bela A reservoir the minimum and maximum dissolved oxygen values ranged from 3.10 mg/l in October 2012 and 4.25 mg/l in March 2013. In the second reservoir Bela B, the dissolved Oxygen content ranged between 3.33 mg/l to 4.50 mg/l. in November 2012 and December 2012.

In the reservoir A of Naubasta the dissolved Oxygen content varied from 357 mg/l in December 2012 to 6.50 mg/l in September 2012. Dissolved Oxygen (DO) in the prime importnat critical facter of any water body which regulates the metabolic processes of flora and founa. It has been reported by some scientist that a good productive water body should have DO content more than 5 mg/l DO content between 1.0 and 5 mg/lit. many have sub lethal effects and between 0.3 to 0.8 mg/litr. would be lethal to many species.

In the reservoir water sample in Bela A the minimum BOD had been recorded as 4.18 mg/l in January 2013 while the maximum vlaue was 5.63 in March 2013. In the second reservoir at Bela B, the maximum BOD value was recorded in November 2012 as 5.73 mg/l while minimum value had been 4.60 mg/l.

In Naubasta A, the BOD values in the water samples rangesd from 2.40 mg/l in September 2012 while it reached to a maximum of 7.48 mg/l in February 2013. In the other pond Naubasta B, the BOD content varied from a minimum of 2.60 mg/l in September 2012 to a maximum of 7.15 mg/l in January 2013.

The BOD test is very usefule in streams pollution management and in evaluation of self purification capacities of water bodies. The highest BOD value of 9 mg/l has recorded in Hussain Sagar Hydrabad, while 6 mg/l has recorded in power lake Chennai (Sulekh Chandra et al. 2012),

Low values of free CO_2 indicated lesser load of organic matter Increased free CO_2 probably atributed to increase in decayed organic matter brought in by drainage water . The concentration ofCarbonates and bicarbonates of calcium are influenced by the pressence and absence of CO_2 gas. Such observations have been reported by Welch 1952. In water samples of BelaA reservoir the free CO_2 values ranged from a minimum of 2.20 mg/l in October 2012 to a maximum of 4.30. In the Second reservoir Bela B the minimum Free CO_2 value was 2.15 mg/l in October 2012 and a maximum of 4.15 mg/l has recorded in February 2013. In Naubasta, the reservoir A had a minimum value of free CO_2 as 3.06 mg/l while a maximum of 4.58 mg/l has recorded in December 2013. In Naubasta B reservoir the minimum and maximum values were found to range as 3.20 mg/l in September 2012 and 4.99 mg/l in November 2012.

In reservoir Bela A the values for Total solids ranged from a minimum of 1005 mg/l in November 2012 to 1350 mg/l in December 2012. In the reservoir B at Bela the minimum solid was was found as 1175 mg/l in March 2013 and maximum had been recorded as 1300 mg/l in December 2013. At Naubasta, the total solids in reservoir A had been estimated as 1005 mg/l in November 2012 and maximum of 1350 mg/l in December 2012 In pond B, at Naubasta the minimum of 1124 mg/l of Total solids had been found while a maximum of 1300 mg/l was found in December 2013. Denoted mainly the various kinds of minerals present in water. However if some organic substances are also present as more aften in polluted water, they may also contribute to the dissolved solids. In the present study, at Bela a reservoir the values ranged from a minimum of 254 mg/l in September 2012 to 380 mg/l in February 2013.

At Naubsta A reservoir the water samples conlained 250 mg/l of dissolved solids in October 2012 to 390 mg/l of dissolved solids in February 2013. In water samples of reservoir B, the minimum values were 255 mg/l to a maximum of 375 mg/l of dissolved solids. Alkalinity of water is its capacity to neutralize acid and is characterized by the presence of by droxyl (OH ions capable of combining hydrogen (H^+) ions in solution. Alkalinity is important for aquatic system because it equilibrated pH changes that occur as a result of photo synthesis. In Bela A reservoir the water samples contained 116 mg/l of alkalinity in September 2012 to a maximum of 134 mg/l in February 2013. In water samples of pond B at Bela, the alkalinity ranged from a minimum of 125.10 mg/l in September 2012 to a maximum of 2012 to a maximum of 138 mg/l in February 2013.

At Naubasta the water samples of A contained 121.33 mg/l to 136.67 mg/l of alkalinity. In pond B, alkalinity values ranged from 125.30 mg/l in September 2012 to 138 mg/l in December 2012.

Chloride occurs naturally in all types of water. In natural fresh waters however, its concentration remains quite low and is generally less than that of bicarbonates. The value of chloride ranged from 15.90 mg/l in September 2012 in BelaA reservoir while a maximum of 21.50 mg/l had been recorded in February 2013. In reservoir B, the chloride content varied from 16.18 mg/l (September 2012) to 22.05/l (in January 2013).

At Naubasta, pond A contained a minimum of 19.10 mg/l (September 2012) In pond B, the chloride cotained varied from 19.10 mg/l (March 2013) to 24.25 mg/l in December 2012. At Bela , A reservoir a water samples contained 25.38 mg/l of Sulphide (March 2013) to 36: 14 mg/l (November 2012) . In water Samples of pond B, the minimum values recorded had been 27.65 mg/l (November 2012). At Naubasta, the water Samples from pond A contained 23.64 mg/l (December 2012) to 36.10 mg/l September 2012). In water samples from pond B the sulphide content varied from 30.10 mg/l in March 2013 to 36.10 mg/l in November 2012. Total hardness values were investivated at Bela and Naubasta. At Bela, the concentration of total hardness value ranged from 244.40 mg/l (October 2012) to 257.44 mg/l (February 2013) at pond A. In water sample from pond B the content had been recordedon 248.10 mg/l and the maximum was 256.10 (Nov. 2012). At Naubasta in water body A the total hardness ranged from 242.50 mg/l (March 2013) to 255.40 mg/l (February 2013). At Pond B the values ranged from 245.15 mg/l (October 2012) to 252.25 (September 2012).

Table 1.1 : Month-wise observation of Water Quality Parameters at Bela A & B during Sept. 2012 to March 2013

S. No.	Parameters	Sept. 2012		Oct. 2012		Nov. 2012		Dec. 2012		Jan 2013		Feb. 2013		March 2013	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B
1.	Transparency (cm)	40.10	44.25	35.60	38.45	36.42	37.45	51.00	52.25	47.25	48.10	43.10	44.25	41.0	38.15
2.	pH	8.10	7.60	7.80	7.85	7.75	7.85	7.60	7.70	7.85	8.10	7.93	8.00	8.15	8.24
3.	Conductivity (limhas/cm)	350.67	353.00	345.10	348.10	342.30	340.10	255.10	254.25	253.33	257.67	280.67	285.45	251.15	265.16
4.	Discovered Oxygen (mg/l)	3.35	3.40	3.10	3.15	3.77	3.33	4.15	4.50	4.13	4.05	3.65	3.14	4.25	4.15
5.	BOD (mg/l)	5.08	5.00	4.60	4.80	5.10	5.73	6.53	6.13	4.18	5.10	4.80	4.60	5.63	5.23
6.	Free Co_2 (mg/l)	2.55	2.50	2.20	2.15	3.30	3.55	3.15	3.8	3.42	3.25	4.30	4.15	3.05	3.15
7.	Total solids (mg/l)	1124	1140	1135	1140	1051	1250	1350	1275	1120	1250	1307	1340	1145	1250
8.	TDS (mg/l)	254	251	256	250	266	275	280	288	325	345	380	374	340	324
9.	Alkalinity (mg/l)	116.10	125.10	126.15	129.40	123.3	126.10	130.15	134.55	120.45	125.10	134.00	138.00	131.10	126.40
10.	Chloride (mg/l)	15.90	16.18	17.80	17.85	18.50	18.30	19.80	19.00	21.25	22.05	21.50	20.25	19.66	21.25
11.	Sulphide (mg/l)	30.69	31.15	32.59	34.10	36.14	35.10	30.47	31.17	30.23	32.15	32.68	31.88	25.38	27.68
12.	Total Hardness (mg/l)	253.38	255.45	244.40	248.10	254.70	256.10	249.30	244.10	248.61	253.50	257.44	255.10	244.53	248.10

Table 1.2 : Month-wise observation of Water Quality Parameters at Bela A & B during Sept. 2012 to March 013

S. No.	**Parameters**	**Sept. 2012**		**Oct. 2012**		**Nov. 2012**		**Dec. 2012**		**Jan 2013**		**Feb. 2013**		**March 2013**	
		A	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
1.	Transparency (cm)	22.53	25.10	42.70	45.00	45.70	46.65	43.67	45.00	41.85	41.07	43.60	45.65	52.10	48.10
2.	pH	8.12	8.04	8.22	8.25	7.70	7.50	7.63	7.80	7.85	8.10	8.25	8.12	7.87	7.50
3.	Conductivity (limhas/cm)	232.00	236.00	255.60	271.00	300.4	350.00	353.33	359.33	356.10	345.00	349.33	345.10	347.33	349.10
4.	Discovered Oxygen (mg/l)	6.45	7.45	5.67	5.25	4.67	4.45	3.57	3.53	4.50	4.57	5.50	4.43	4.10	5.50
5.	BOD (mg/l)	2.40	2.60	3.00	3.20	3.49	4.30	5.30	5.25	6.53	7.15	7.48	5.25	4.67	4.40
6.	Free Co_2 (mg/l)	3.55	3.20	3.40	3.35	4.55	4.99	4.58	4.38	4.38	3.78	3.62	3.65	3.06	3.25
7.	Total solids (mg/l)	1075	1124	1140	1125	1005	1250	1350	1300	1211	1250	1300	1275	1145	1175
8.	TDS (mg/l)	260	255	250	262	266	278	280	292	340	345	390	375	330	314
9.	Alkalinity (mg/l)	121.33	125.30	128.00	130.00	132.60	132.00	135.33	138.00	136.67	130.00	125.00	126.00	124	128
10.	Chloride (mg/l)	19.10	20.30	20.95	21.30	22.64	22.48	23.64	26.25	21.40	21.22	20.67	18.99	20.10	19.10
11.	Sulphide (mg/l)	36.10	32.15	32.40	34.15	35.14	36.10	30.45	30.17	31.75	32.25	32.65	31.68	26.48	30.10
12.	Total Hardness (mg/l)	250.18	252.25	244.00	245.15	250.10	252.10	254.30	248.10	254.15	244.10	255.40	250.10	242.50	248.25

Table 1.3 Drinking water standards of Ministry of Works and Housing (1975)

Characteristics	Acceptable	Cause for Rejection
Turbidity, J.T.U. sclae	2.5	10
Colour (Pt-Co scale)	5.0	25
Taste & odour	Unobjectionable	Unobjectionable
pH	7.0-8.5	6.5-9.2
Dissolved solids, mg/l	200	1500
Total Hardness (as $CaCO_3$), mg/l	200	600
Chlorides (as Cl), mg/l	200	1000
Sulphates (as SO_4) mg/l	1.0	400
Fluorides (as F), mg/l	45	1.5
Nitrates as (NO_3), mg/l	75	45
Calcium (as Ca), mg/l	30	200
Magnesium (as Mg), mg/l	0.1	150
Iron (as Fe), mg/l	0.05	1.0
Copper (as Cu), mg/l	0.05	0.5
Zinc (as Zn), mg/l	5.0	1.5
Phenolic compounds, mg/l	0.001	15.0
Detergents anionic, mg/l	0.2	0.002
Detergents anionic, mg/l	0.01	1.0
Mineral oil, mg/l	0.05	0.3
Arsenic, mg/l	0.01	0.05
Chromium(as Cr^{+6}) mg/l	0.05	0.01
Cyanides, mg/l	0.05	0.05
Lead, mg/l	0.1	0.1
Selenium, mg/l	0.01	0.01
Mercury, mg/l	0.001	0.001
PCBs, mg/l	0.2	0.2
Gross Alpha activity, PCi/L	3.0	0.3
Gross Beta activity, PCi/l	30.0	30.0

Table 1.4 Classification and zoning of water bodies (CPCB 1979

	Designated –best-use	Nomenclature for the class of water
Freshwater		
1.	Drinking water source without conventional treatment but after disinfection	Class A
2.	Outdoor bathing	Class B
3.	Drinking water source with conventional treatment followed by disinfection	Class C
4.	Propagation of wildlife, fishereis	Class D
5.	Irrigation, industrial cooling, and controlled waste disposal.	Class E

Classification of Inland Surface Waters (cPCB Standards)

	Paramters	Class of Water*				
		A	B	C	D	E
1.	Dissolved oxygen, mg/L Min	6	5	4	-	-
2.	Biochemical oxygen demand, mg/l Max	2	3	3	-	-
3	** total coliform organisms, MPN/100 ml,Max	50	500	5000	-	-
4.	Total dissolved soklids, mg/L, Max	500	-	1500	-	2100
5.	Chloride (as Cl). mg/L. Max	250	-	600	-	600
5.	Chloride (as Cl), mg/L, Max	10	300	300	-	-
6.	Colour, Hazen units, Max	-	-	-	-	26
7.	Sodium Absorption Ratio, Max.	-	-	-	-	2
8.	Boron (as B) mg/l, Max	400	-	400	-	1000
9.	Sulphates (as SO_4) mg/L, Max	20	-	50	-	-
10.	Nitrates (as SO_4) mg/l, Max	-	-	-	-	-
11.	Free ammonia (as N), mg/l, Max	-	-	-	1.2	2.25
12.	Conductivity at 25^0C. micro-mhos/cm. Max.	6.5	-	-	10	
13.	pH value	8.5	65-85	6.5-8.5	6.5-8.5	6.0-8.0
14.	Arsenic (as As), mg/l, Max	0.05	0.2	02	-	-
15.	Iron (as Fe) mg/l , Max	0.3	-	50	-	-
16.	Fluorides (as F), mg/l Max	1.5	15	1.5	-	-
17.	Lead (as Pb), mg/l, Max	0.1	-	01	-	-
18.	Copper (as Cu), mg/l, Max	1.5	-	15	-	-
19.	Zinc (as Zn) mg/l, Max	15	-	15	-	-

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