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# Quality of Surface Water at the Savar and Its Adjacent Areas

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***Abstract***

*Savar and its adjacent low-lying areas are Savar pourashava and Tetuljhora union. All these surface areas are vulnerable to pollution from disposal of solid waste, untreated industrial effluents and municipal wastewater, runoff from various chemical, fertilizer and pesticides. The present study has been conducted to evaluate the important physical, chemical and biological water quality parameters and scenarios of the Savar and its adjacent areas through a field survey during dry season in 2006. The investigation results have been compared with the Bangladesh and WHO standard for surface water. The parameters namely pH, Dissolve Oxygen (DO), Biological Oxygen Demand (BOD) Chemical Oxygen Demand (COD), Total Dissolve Oxygen (TDS), Electrical Conductivity (EC), Nitrate-Nitrogen ($NO_3$_N), Phosphate ($PO_4$), Ammonia-Nitrogen ($NH_3$-N), Salinity, Chloride, Nacl, Iron, Cadmium, Magnesium and Arsenic were tested in this research. The test results indicate that all the surface water of these areas are highly polluted. The important surface water quality, when compare with the earlier values, indicate that the degree of pollution of these areas are gradually increasing with time. So, this paper focuses on the study and analysis of important surface water quality of the mentioned areas.*

## Introduction

Mankind in the 21st century is faced with unprecedented challenges imposed by water scarcity, pollution and water quality degradation. In recent years, Bangladesh experienced rapid industrialization and as a consequence the release of waste materials has been increased. In Bangladesh, industrial wastes and effluents are discharged into drains, canals and rivers at random without treatments. They pollute our natural

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water systems, ground water and sediments, which act as sink. They thereby create serious environmental hazards; endanger human health and cause problems to aquatic lives (Ullah *et. al.* 1995). These kinds of human hazards are commonly seen in the Savar and its adjacent industrial areas.

Savar (lies between $23^0$45.5´ N to $24^0$ 02´N and $90^0$11´ E to $90^0$20.5´ E), which is known as the suburb of capital Dhaka has emerged as a new industrial town (Jahan *et. al.* 2005). As Savar upazila has some standard opportunities for living with availability of cheap land and labor and excellent communication with Dhaka city, the industrialization is intense here. The wastewater discharged from various factories *i.e.* textile, dying, food, chemical, pharmaceuticals, plastic, steel, paint, ceramic fall into the surrounding land, canals and rivers. But still the characteristics of those effluents have not been determined to know the extent of their predicted detrimental effects on flora and fauna including human. So far, Chowdhury *et. al.* (1994) studied the aspect of industrialization-urbanization and associate pollution problems along the Sitalakhya river in Savar area and he found that the water was polluted. For these regions fresh research was conducted in the Savar and its adjacent areas. Bangladesh passed the Environmental Conservation Act, 1995 (ECA, 1995) and also the Environmental Conservation Rules, 1997 (ECR, 1997) and there was a provision issued by DoE to setup ETP (Effluent Treatment Plant) for the industries.

The objectives of this study were to determine the concentrations of different pollutants in the effluents of industries from point sources, which may help in formulating better strategies and guidelines to reduce the pollution from the industries.

About one hundred industries existed in Savar pourashava and Tetuljhora union, the effluents of which went down to the Dhalaswari river through several canals and the samples of water were collected from the meeting point of those canals and Dhalaswari river and from different other places which are presented in the Table below (Table-1).

Samples were collected twice in January and December in 2006 and preserved for analysis following APHA (1992). Collected sample water was analyzed by using the instruments mentioned below and the data were averaged:

1. pH meter (Glass electrode pH meter calomel reference electrode meter- Model-7, Japan) to determine the pH,
2. Conductivity meter (CM-55 TOA, Japan) to measure Electrical Conductivity (EC), Total Dissolved Solid (TDS) and Total Suspended Solid (TSS),
3. Turbidity meter (HACH Ratio Turbid meter model 18900) to measure turbidity,

4. HACH Test Kit (Model FF-2, USA) to determine the Dissolved oxygen (DO), Biological Oxygen Demand ($BOD_5$), Ammonium Nitrogen ($NH_4^+$-N), Nitrate Nitrogen ($NO_3$-N), Chemical Oxygen Demand (COD) and Chloride ($Cl^-$),
5. Calcium ($Ca^{2+}$) and Magnesium ion ($Mg^{2+}$) were determined by using UV-visible Spectrophotometer (160A, Model AA-680 Shimadzu, Japan),
6. Atomic Absorption Spectrophotometer (AAS, Model AA-680 Shimadzu, Japan) was used to determine Cadmium (Cd), Chromium (Cr), Manganese (Mn) and Arsenic (As).

Table. 1 The collected water samples and their location at savar areas.

| Water Sample Code | Sample ID* | Location |
|---|---|---|
| WW-1 | 1 | Meeting point of canal and the Dhalaswari river. At the rainy season the area was flooded. The Upstream effluents of all area discharge through this point. |
| WD- 1 | 2 | Same Place (WW-1) in dry season |
| WW-2 | 3 | Upstream of the north side of Bank-town in rainy season |
| WD- 2 | 4 | Same Place (WW-2) in dry season |
| WW-3 | 5 | Effluent point of Pakiza Print Ltd. (the east side of the road between Savar bus stand and thana stand) in rainy season. |
| WD- 3 | 6 | Same Place (WW-3) in dry season. |
| WW-4 | 7 | Downstream of the river under the bridge situated at the east of the Dhaka-Aricha road, which lies to the north of Bank town in rainy season. |
| WD- 4 | 8 | Same Place (WW-4) in dry season. |
| WW-5 | 9 | South side of the river flowing beside the south of the Bank town in rainy season. |
| WD- 5 | 10 | Same Place (WW-5) in dry season |

WW = Water sample in winter season and WD = Water sample in dry season.

All the chemical analyses of water were carried out in the laboratory of the Department of Environmental Science, State University of Bangladesh.

## Results & Discussions

***Dissolved oxygen (DO):*** Dissolved oxygen (DO) is a significant factor in water quality, pollution control, and several treatment processes. The DO ranged from 2.1 to 4.3 mg/L during the wet season while 0.8 to 1.8 mg/L during the dry season (Table 2) and these values were below the permissible level outlined by DoE (Table 3) for use in agriculture, good drinking water and release in the inland surface water. DO is also considered vital for the aquatic life. According to Boyd (1982) DO less than 1 mg/l is very much lethal for fish survival, but poor reproduction and slow growth occur in the ranges of 1 to 5 mg/l of DO. EPA (1985) standard recommend DO of 4.0 to 6.0 mg/l for growth and survival of all aquatic life. So, the sampled water from Savar had DO below the acceptable range in all aspects and should be treated in ETP.

***Biological Oxygen Demand (BOD):*** Biological oxygen demand is the most commonly used parameter to define the strength of industrial wastewater. Widest application is in measuring waste loadings to treatment plants and in evaluating the efficiency of such treatment systems. In addition, the BOD test is used to determine the relative oxygen requirements of treated effluents and polluted waters. In the sampled water, the BOD ranged from 100 to 175 mg/L in the wet season while 170 to 255 mg/L in the dry season (Table 2). According to DoE (Table 3) the standard value for Agriculture in Bangladesh is 250 mg/L which indicates that the BOD values of the effluents were in the acceptable range for agricultural purposes in wet season but these ranges were not suitable for release in the inland surface water from industrial waste (50 mg/L) and drinking water (0.2 mg/L). BOD itself is not harmful to fish but the harmfulness of low DO caused by a high BOD. According to EIFAC standard (Lloyd, 1992), BOD should be in the range of below 6 mg/l for freshwater fishes specially cyprinids. So, the sampled water might be lethal for fishes and might contributed to the loss of fish biodiversity in those areas.

***Chemical Oxygen Demand (COD):*** In the wet season the chemical oxygen demand (COD) ranged from 190 to 255 mg/L and in the dry season it ranged from 250 to 320 mg/L (Table 2). According to the standard value set by DoE (Table 3) for COD, these values were in the acceptable ranges for use in agriculture and release in inland surface water while this water was not suitable as good drinking water.

***pH :*** The pH of water is a measure of the hydrogen ion concentration on a scale of 0 (very acidic) to 14 (very alkaline) with pH 7 being the neutral point (Stirling, 1990). Several other variables of water depend on it. The pH values of the water samples ranged from 7.60 to 8.70 in the wet season while 5.7 to 7.65 in the dry season. The standard set by DoE for pH to use in agriculture, drinking water and release in inland surface water, the values are 6.5 to 8.5, 6.5 to 8.5 and 6 to 9 respectively while according to FAO (1985) the normal pH range for irrigation water is from 6.5 to 8.4. In one water sampling area (WW-3) the pH of water was higher (8.7) in wet season while only one water sampling area (WD-5) had the pH value in acceptable range according to DoE. According to Boyd (1982), the pH range for good growth of fish is 6.5 to 9. However, EPA (1985) standard of pH range is 6.0-8.5 for all other aquatic organisms. So, the sampled water was mostly not suitable in dry season for low pH values.

***Electrical conductivity (EC):*** Electrical conductivity is usually used for indicating the total concentrations of the ionized constituents of water. It is closely related to the sum of the cations or anions as determined chemically, and it usually correlates closely with TDS (Rouse, 1979). The EC was recorded 192 to 435 µS/m in wet season while 372 to 660 µS/m in dry season (Table 2). According to standard value of this parameter set by DoE (Table 3) it showed lower value and this water would not need treatment to reduce EC.

***Turbidity:*** Insoluble particles of soil, organics, microorganisms, and other materials impede the passage of light through water by scattering and absorbing the rays. Turbidity was recorded as 11 to 14 JTU in wet season while 12 to 15 JTU in dry season. (Table 2) As the acceptable range for turbidity is 10 JTU set by DoE for agricultural use and drinking water, so the water sampled could not be used for those purposes.

***Total dissolved solids (TDS):*** TDS is the most important parameter for water quality especially for irrigation water since it controls the availability of water to plants through osmotic pressure regulating mechanisms (ADB 1994). TDS values were observed from1100 to 1600 mg/L in wet season while and 1790 to 2100 mg/L in dry season. According to standard value of this parameter set by DoE (Table 3), this water could not be used for agricultural purposes and not suitable for drinking water but could be released into the surface water while according to EPA (1985) standard maximum TDS of 500 mg/l is the acceptable range for diverse fish population and aquatic life. So, the values of TDS in sample waters were not suitable for fish and other aquatic fauna.

***The total suspended solids (TSS):*** The total suspended solids (TSS) ranged from 132 to 715 mg/L in wet season while 512 to 1020 mg/L in dry season. The permissible limit for agricultural use is 100 mg/L and for drinking water is 10 mg/L while wastewater from industrial units to release in inland surface water is 150 mg/L. So, the sampled water was only suitable for release in inland surface water.

***$NH_4^+$-N :*** The $NH_4^+$-N ranged from 5.2 to 23.5 mg/L in the wet season and 9.1 to 18.6 in the dry season. (Table 2) These ranges were above the permissible ranges (Table 3) for standards for Agriculture (0.5 mg/L), standard for drinking water (0.5 mg/L) and standard for release of wastewater from industry in inland surface water (5 mg/L). The acceptable range of ammonia nitrate for fish growth is below 0.52 mg/l (Boyd, 1982), which indicated that the sampled water had no permissible range of ammonia nitrate for fish growth. EPA (1985) standard also set the same range for all aquatic life.

***$NO_3$-N:*** $NO_3$-N values observed from 6.3 to 19.2 mg/L in wet season and 10.5 to 22.8 mg/L in dry season. Only the values of the samples of WW-2 and WW-4 were within the acceptable range for agricultural use, drinking purposes and for releasing in the inland surface water according to DoE standard (Table 3). But fish grow and survive at 0.5 mg/l nitrate –N (Boyd, 1982) which indicates that all the sampled water lost their suitability for fish survival. High concentrations of nitrate-N may cause excessive plant growth leading to phytoplankton bloom leading to more toxification of the water system vulnerable for the survival of aquatic organisms (Stirling 1990). Sensitive crops may be affected by nitrogen concentrations above 5 mg/l. Most other crops are relatively unaffected until nitrogen exceeds 30 mg/l. (FAO 1985). High nitrogen levels may be beneficial during early growth stages but may cause yield losses during the later flowering and fruiting stages. Less than 5 mg/l N has little effect, even on nitrogen sensitive crops, but may stimulate nuisance growth of algae and aquatic plants in streams, lakes, canals and drainage ditches (FAO, 1985).

***Chloride ($Cl^-$):*** Chloride is one of the important factors in water quality. High chloride content in water bodies harms metallic pipes and structures as well as agricultural crops (ADB, 1994). Here the chloride values were observed 86 to 352 mg/L in wet season and 215 to 412 in dry season but the standard value for agriculture in Bangladesh, standard for drinking water and wastewater from industrial units to release in inland surface water is 600 mg/L, 150-600 mg/L and 600 mg/L respectively and the water could be used for those purposes.

***Calcium (Ca):*** The level of calcium was recorded as 3 to 8 mg/L in wet season while 4 to 16 mg/L in dry season (Table 2). DoE set the permissible range of Ca for use in agriculture is 100 mg/L, for use as drinking water is 75 mg/L which indicates that the sampled water was suitable for those purposes.

***Magnesium (Mg):*** Magnesium was found 11 to 22 mg/L in wet season and 31 to 37 mg/L in dry season. (Table 2) DoE set the permissible range of Mg for use in agriculture is 30mg/L, for use as drinking water is 30-35 mg/L. So, the sampled water was suitable in the wet season while unsuitable for those purposes during dry season. According to FAO (1985) soils containing high levels of exchangeable magnesium are often thought to be troubled with soil infiltration problems. The role of magnesium in causing or partly causing these problems is not well documented but researchers from several irrigated areas have studied the problem. One concern, however, is that productivity is sometimes reported to be low on high magnesium soils or on soils being irrigated with high magnesium water even though infiltration problems may not be evident. The effect may be due to a magnesium-induced calcium deficiency caused by high levels of exchangeable magnesium in the soil.

***Arsenic (As):*** Arsenic poisoning is currently a devastating problem in Bangladesh. Arsenic (As) ranged from 1.3 to 4.9 mg/L in wet season and

1.6 to 5.1 mg/L in dry season but in case of Arsenic, the standard value for agriculture in Bangladesh, standard for drinking water and wastewater from industrial units to release in inland surface water is 0.05 mg/L, 0.05 mg/L and 0.2 mg/L respectively (DoE). So, the level of arsenic was above the permissible level and thus not suitable for use in the above mentioned purposes. Also, the toxicity of arsenic of plants varies widely, ranging from 12 mg/l for Sudan grass to less than 0.05 mg/l for rice (FAO 1985).

***Cadmium (Cd):*** Cadmium is one of the heavy metal, which is toxic to animals and plants. Cadmium (Cd) was ranged from trace to 0.9 mg/L and trace to 1.2 mg/L in wet and dry season respectively. According to the standard value set by DoE for Cd, these values were in the acceptable ranges for use in agriculture, drinking water and release in inland surface water from industrial units. According to (FAO 1985) the permissible limit for agricultural crops is 0.01 mg/L, which indicates that, the water from the industries at Savar were not suitable for agricultural crops.

***Chromium (Cr):*** Chromium (Cr) ranged from trace to 5.0 mg/L and 0.2 to 2.5 mg/L in wet and dry season respectively. According to the standard value set by DoE (Table 2) for Cr, these values were in the permissible ranges for use in agriculture, drinking water and release in inland surface water from industrial units.

***Manganese (Mn):*** Manganese (Mn) values observed from 90 to 415 mg/L in wet season and 163 to 470 mg/L in dry season. All the values of the samples were beyond the permissible range to use in agriculture, drinking water and release in (DoE).

## Conclusion and Recommendations

A study was conducted to determine the physico-chemical characteristics and metallic contents of the surface water of Savar and its adjacent low-lying areas, which is directly contaminated by effluents from various industries. DO ranged from 2.1 to 4.3 mg/L, BOD ranged from 100 to 175 mg/L, chemical oxygen demand (COD) ranged from 190 to 255 mg/L, pH values of the water samples ranged from 7.60 to 8.70, the EC was recorded 192 to 435 µS/m, Turbidity was recorded as 11 to 14 JTU, TDS values were observed from1100 to 1600 mg/L, total suspended solids (TSS) ranged from 132 to 715 mg/L, $NH_4^+$-N ranged from 5.2 to 23.5 mg/L, $NO_3$-N values observed from 6.3 to 19.2 mg/L, chloride (Cl-) values were observed 86 to 352 mg/L, calcium was recorded as 3 to 8 mg/L, Magnesium was found 11 to 22 mg/L, Arsenic (As) ranged from 1.3 to 4.9 mg/L, Cadmium (Cd) was ranged from trace to 0.9 mg/L, Chromium (Cr) ranged from trace to 5.0 mg/L, Manganese (Mn) values observed from 90 to 415 mg/L during the wet season while in the dry season The DO ranged from 0.8 to 1.8 mg/L , BOD ranged from 170 to 255 mg/L, COD ranged from 250 to 320 mg/L, pH values of the water samples ranged from 5.7 to 7.65, EC was recorded as 372 to 660 µS/m, Turbidity was recorded as 12 to 15 JTU, TDS values were observed from 1790 to 2100 mg/L, TSS ranged from 512 to 1020 mg/L, $NH_4^+$-N ranged from 9.1 to 18.6, $NO_3$-N values observed from 10.5 to 22.8 mg/L, chloride values were observed 215 to 412, calcium was recorded as 4 to 16 mg/L, Magnesium was found 31 to 37 mg/L, As ranged from 1.6 to 5.1 mg/L, Cd was ranged from trace to 1.2 mg/L, Cr ranged from 0.2 to 2.5 mg/L, Mn values observed from 163 to 470 mg/L. pH, turbidity, TDS, $NH_4^+$-N, $NO_3$-N, Mg ( in dry season), As, Mn values of the effluents were not in the acceptable range for agricultural purposes. BOD, pH (in dry season), turbidity, $NH_4^+$-N, $NO_3$-N (in three stations), Mg (dry season), As, Mn values were not suitable for release in inland surface water. BOD, COD, pH (in dry season), turbidity, TDS, $NH_4^+$-N, $NO_3$-N (in three stations), Mg (in dry season), As, Cd, Mn values of the effluents were not suitable for drinking water. So, the area is vulnerable for human life and animal.

Once upon a time Savar and its adjacent low-lying areas and wetland were cultivated rich in biodiversity for normal ecosystems functioning. Now a day due to the industrial development in that area the water is polluted by industrial wastage like chemicals and industrial byproducts. Many of the chemicals substance are toxic or even carcinogenic. Pathogens can obviously produce waterborne disease in either human or animal hosts. Finally, the area is vulnerable not only for wild and domestic flora and fauna but also for the human.

To mitigate the disastrous problem (i.) every industry must follow and apply the DoE environmental guidelines, (ii) effluent Treatment Plant should be set up for all industries in Savar area and every industry should follow it, (iii) all industries must use environment friendly chemicals and machineries, (iv) massive awareness program for the clean environment should be launched and (v) effective monitoring of faunal and floral diversity should be done.

**References**

1. ADB (1994), The Environment Program: Past, Present and Future. Asian Development Bank, Manila, Philippines.
2. APHA (1992), Standard methods for the examination of water and wastewater (18th ed. APHA/AWWA/WEF) American public Health Association, Washington. pp. 1100.
3. Boyd, C.E. 1982. Water quality managment for pond fish culture. Developments in aquaculture and fisheries science No. 9. Elsevier. xi, 318 pp.
4. Chowdhury, K. R., Alam, A. M. S., Shamsuddin, S. D., Shakhawat, H. and Haque, S. (1994), A Preliminary Assessment of Water and Sediment Pollution Load Along the Coasts of Chittagong and Cox’s Bazar, The Journal of NOAMI, Vol 11, No. 2, December 1994
5. EPA; Environmental protection agency, USA (1985), National interim Primary Drinking Water Standards as given by laws E.A. in Water Pollution and Toxicology. Encyclopaedia of Physical Science and Technology 2nd ed; 17, p. 525.

6. FAO (1985), Water Quality for Agriculture. Irrigation and Drainage Paper No. 29, Rev. 1. Food and Agriculture Organization of the United Nations, Rome.
7. Huq, E. M. (2003), A Compilation of Environmental Laws of Bangladesh, Department of Environment, Ministry of Environment and Forest, Peoples Republic of Bangladesh.
8. Jahan, R., Kabir, M., Khan, M.M.H., (2005), Opinions of the participants of the key informant discussions about the health care services in rural Bangladesh: a case study of Savar Thana. Chiang Mai University (CMU) Journal; 4: 345-354.
9. Lloyd, R (1992), Pollution and Freshwater Fish. Fishing New Books, 176 p. Blackwell Publishing.
10. Rouse, J. V. (1979), Evaluation and Control of Ground-Water Quality in the Rocky Mountain Area. – In: Argall, G. O. & Brawner, C. O.: Mine Drainage – Proceedings of the First International Mine Drainage Symposium. – p. 154-160; San Francisco (Freeman).
11. Stirling, H.P. (Ed.), Beveridge, M.C.M; Ross, L.G. and Phillips, M.J. (1985), Chemical and biological methods of water analysis for aquaculturists. Stirling. 119 pp
12. Ullah S.M., Aruzzaman, M. N., and Gerzabek, M. H. (1995), Heavy metal and microbiological pollution water and sediments by industrial wastes, effluents and slums around Dhaka city. In: Tropical Limnology (KH Timotius and F Goltenboth Eds.). 3: 179 - 186.

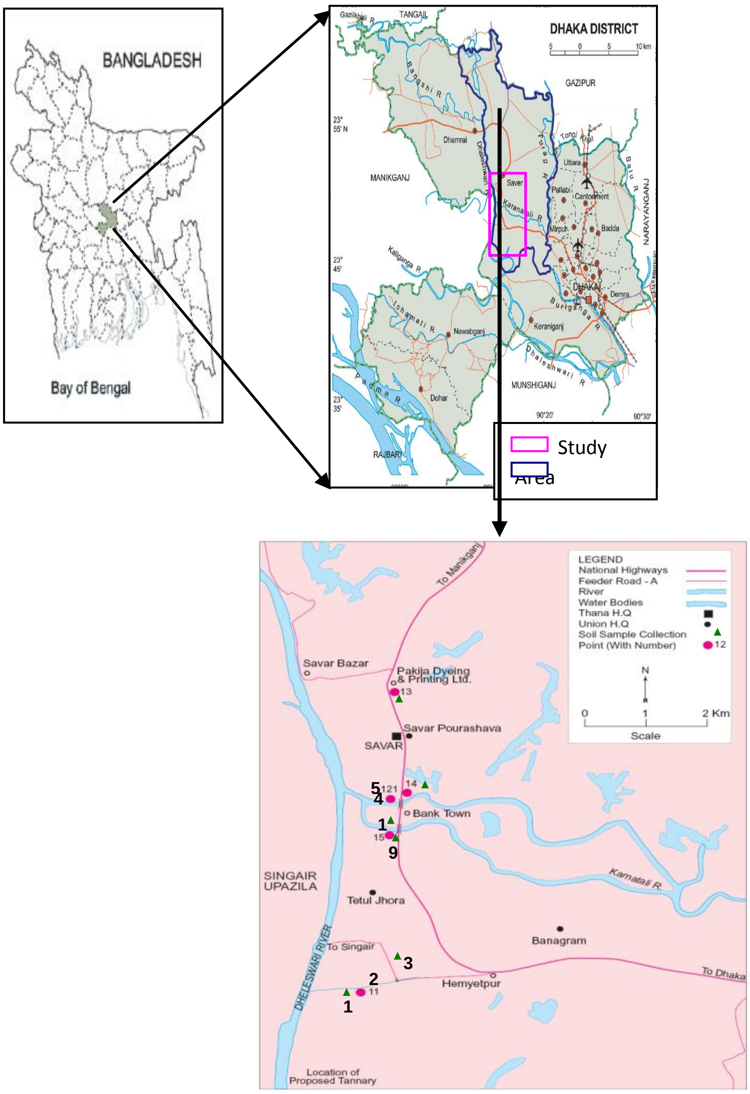

Table 2 Chemical Composition of Water Sample

| Seasons | Water Sample Code | Sample ID | **DO (**mg/L) | **BOD** (mg/L**)** | **COD** (mg/L) | **pH** | **$NH_4^+$-N** (mg/L) | **$NO_3$-N** (mg/L) | **Turbidity** (JTU) | **TDS** (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Safe limits | | >3 | 0-3 | 0-5 | | | 0-1.5 | | |
| **Wet** | WW-1 | 1 | 3.0 | 130 | 190 | 7.60 | 15.4 | 19.2 | 12 | 1300 |
| | WW-2 | 3 | 2.5 | 110 | 190 | 8.50 | 5.2 | 7.5 | 11 | 1200 |
| | WW-3 | 5 | 2.2 | 150 | 230 | 6.65 | 14.3 | 12.5 | 13 | 1500 |
| | WW-4 | 7 | 3.2 | 100 | 210 | 8.15 | 10.3 | 6.3 | 13 | 1300 |
| | WW-5 | 9 | 3.1 | 135 | 245 | 8.20 | 7.5 | 7.9 | 12 | 1100 |
| **Dry** | WD-1 | 2 | 1.5 | 255 | 310 | 6.70 | 12.5 | 19.6 | 12 | 2100 |
| | WD-2 | 4 | 1.1 | 170 | 250 | 8.64 | 18.6 | 11.9 | 15 | 1800 |
| | WD-3 | 6 | 1.8 | 210 | 290 | 8.60 | 9.1 | 8.5 | 12 | 1790 |
| | WD-4 | 8 | 0.8 | 240 | 320 | 7.84 | 12.7 | 10.1 | 12 | 1900 |
| | WD-5 | 10 | 1.0 | 230 | 295 | 8.62 | 11.8 | 22.8 | 13 | 2100 |

| Seasons | Water Sample Code | Sample ID | **TSS** (mg/L) | **EC** (µS/m) | **Ca** (mg/L) | **Mg** (mg/L) | **As** (ppm) | **Cd** (ppm) | **Cr** (ppm) | **Mn** (ppm) | **Cl-** (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Safe limits | | | | | | | | | | |
| **Wet** | WW-1 | 1 | 132 | 180 | 5 | 16 | 2.5 | trace | 2.3 | 152 | 182 |
| | WW-2 | 3 | 520 | 322 | 7 | 11 | 1.3 | trace | trace | 90 | 205 |
| | WW-3 | 5 | 328 | 285 | 3 | 19 | 2.6 | 0.6 | 0.8 | 235 | 86 |
| | WW-4 | 7 | 280 | 115 | 6 | 20 | 1.2 | trace | trace | 130 | 170 |
| | WW-5 | 9 | 620 | 310 | 4 | 22 | 4.1 | 0.9 | 0.9 | 415 | 264 |
| **Dry** | WD-1 | 2 | 512 | 554 | 4 | 35 | 3.4 | 0.7 | 1.8 | 261 | 215 |
| | WD-2 | 4 | 640 | 395 | 12 | 27 | 1.6 | 0.5 | 0.5 | 190 | 395 |
| | WD-3 | 6 | 835 | 660 | 16 | 26 | 1.8 | trace | 0.2 | 163 | 388 |
| | WD-4 | 8 | 1020 | 585 | 11 | 31 | 4.2 | 1.1 | 1.1 | 470 | 412 |
| | WD-5 | 10 | 410 | 372 | 7 | 32 | 3.5 | 1.2 | 2.5 | 184 | 227 |

Table: 3: Comparative Study of Water Sample (Seasonal Variation with Standard Value)

| Parameters | Range of Sample Value (seasonal) | Standard Value of Bangladesh in Agriculture (DoE) | Standard for Good Drinking Water (DoE) | Standard of Waste from Industrial Units or Projects Waste (DoE) | | |
|---|---|---|---|---|---|---|
| | | | | Inland Surface Water | Public Sewerage system connected to treatment at Second Stage | Irrigated Land |
| Biological Oxygen Demand (BOD) | Wet -100 to 175 (mg/L)<br>Dry -170 to 255 | 250 | 0.2 | 50 | 250 | 100 |
| Calcium (Ca) | Wet -3 to 8 (mg/L)<br>Dry-4 to 16 | 100 | 75 | - | - | - |
| Magnesium (Mg) | Wet -11 to 23 (mg/L)<br>Dry-26 to 35 | 30 | 30-35 | - | - | - |
| Chloride (Cl -) | Wet -86 to 352 (mg/L)<br>Dry-215 to 412 | 600 | 150-600 | 600 | 600 | 600 |
| Carbonate (CO32-) | Wet -38 to 125 (mg/L)<br>Dry-42 to 147 | - | | - | - | - |
| Chemical Oxygen Demand (COD) | Wet -190 to 255 (mg/L)<br>Dry-250 to 320 | 200 | 4 | 200 | 400 | 400 |
| Dissolved Oxygen (DO) | Wet -2.1 to 4.3 (mg/L)<br>Dry-0.8 to 1.8 | 4.5 – 8 | 6 | 4.5-8 | 4.5-8 | 4.5-8 |
| Electrical Conductivity (EC) | Wet -92 to 435(µS/m)25ºc<br>Dry-372 to 660 | 500 | | 1200 micro mho/cm | 1200 micro mho/cm | 1200 micro mho/cm |
| Bi-Carbonate (HCO3-) | Wet -190 to 640 (mg/L)<br>Dry-320 to 424 | - | | - | - | - |
| Potassium (K+) | Wet -13 to 54 (mg/L)<br>Dry-25 to 49 | 12 | 12 | - | - | |
| Sodium (Na+) | Wet -24 to 72 (mg/L)<br>Dry-32 to 95 | - | 200 | - | - | - |
| | Wet -2.9 to 23.5 (mg/L) | 0.5 | 0.5 | 5 | 5 | 15 |

Quality of Surface Water at the Savar and Its Adjacent Areas

| Parameters | Range of Sample Value (seasonal) | Standard Value of Bangladesh in Agriculture (DoE) | Standard for Good Drinking Water (DoE) | Standard of Waste from Industrial Units or Projects Waste (DoE) | | |
|---|---|---|---|---|---|---|
| | | | | Inland Surface Water | Public Sewerage system connected to treatment at Second Stage | Irrigated Land |
| NH4+ - N | Dry-9.1 to 18.6 | | | | | |
| NO3-N | Wet -6.3 to 19.2 (mg/L)<br>Dry-8.5 to 22.8 | <10 | 10 | 10 | - | 10 |
| pH | Wet -5.98 to 8.5<br>Dry-6.7 to 8.64 | 6.5-8.5 | 6.5-8.5 | 6-9 | 6-9 | 6-9 |
| Sulphate (SO4=) | Wet -90 to 491 (mg/L)<br>Dry-85 to 198 | 250 | 400 | - | - | - |
| Total Dissolved Solids (TDS) | Wet-1100 to 1600 (mg/L)<br>Dry-1790 to 2100 | 500 | 1000 | 2100 micro mho/cm | 2100 micro mho/cm | 2100 micro mho/cm |
| Total Suspended Solids (TSS) | Wet -132 to 715 (mg/L)<br>Dry-512 to 1020 | 100 | 10 | 150 | 150 | 150 |
| Turbidity (JTU) | Wet -11 to 14<br>Dry-12 to 15 | 10 | 10 | | | |
| Arsenic (As) | Wet -1.1 to 4.9 (ppm)<br>Dry-1.6 to 4.2 | 0.05 | 0.05 | 0.2 | 0.05 | 0.2 |
| Cadmium (Cd) | Wet -trace to 0.9 (ppm)<br>Dry-trace to 1.2 | 0.05 | 0.005 | 0.05 | 0.5 | 0.5 |
| Chromium (Cr) | Wet - trace to 5.0 (ppm)<br>Dry-0.2 to 2.5 | 0.05 | 0.05 | 0.5 | 1.0 | 1.0 |
| Manganese (Mn) | Wet -90 to 415 (ppm)<br>Dry-163 to 470 | <0.05 | 0.1 | 5 | 5 | 5 |

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