Determination of quality of different drinking water collected from Purba and Paschim Midnapur, West Bengal, India

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ABSTRACT

The water quality of different drinking water source collected from Panskura, Ghatal and Geonkhali in West Bengal was analyzed. Water samples were collected from residential area of Panskura (Pond water, 400ft, 170 ft 121ft &70 ft depth deep tube well water), Ghatal municipality (Shilabati river water and Ghatal water plan after bleaching), Geonkhali water treatment plant (before and after bleaching). All water samples were subjected to bacteriological (coliform and fecal coliform) and physiochemical studies (P^H, Conductance, Hardness, Alkalinity, DO, BOD, COD and TDS, TSS) to measure the water quality index (WQI), using standard bacteriological and Physiochemical methods. This study was intended to ascertain the quality of water for public consumption, recreation and other purposes. Present result indicate that water quality of all studied area are Good with respect to WQI value and excellent for drinking purpose collected from Geonkhali water treatment plant after bleaching. So, this result informed that proper treatment is required for excellent water quality before water consumption otherwise may also trigger outbreaks of waterborne disease.

Introduction

Water is a dynamic renewable natural resource. Its availability with good quality and adequate quantity is very important for human life and other purposes. In general, the quality of water is equally important as the quantity. Therefore, water quality is considered as an important factor to judge environment changes which are strongly associated with social and economic development (Miller *et al*, 1986). In developing countries about 1.8 million people, mostly children, die every year as a result of water related diseases (WHO, 2004). Nowadays, surface water quality became a critical issue in many countries; especially due to the concern that freshwater will be a scarce resource in the future, therefore, water quality monitoring program is necessary for the protection of freshwater resources (Wunderlin *et al*, 2000).

Water quality is used to describe the

condition of the water, including its chemical, physical and biological characteristics, usually with respect to its suitability for a particular purpose (i.e., drinking, swimming or fishing) (Diersing, N. 2009, Sargaonkar, A. 2003).Water quality is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose (Johnson *et al,* 1997). It is most frequently used by reference to a set of standards against which compliance can be assessed. Monitoring programs of aquatic systems play a significant role in water quality control since it is necessary to know the contamination degree so as not to fail in the attempt to regulate its impact (Almeida *et al,* 2007). However, the quality is difficult to evaluate from a large number of samples, each containing concentrations for many parameters (Almeida *et al*, 2007). On the other hand, Water Quality Index (WQI) is a very useful and efficient method for assessing the suitability of water quality. It is also a very useful tool for communicating the information on overall quality of water (Buchanan *et al,* 2009) to the concerned citizens and policy makers. WQI is a dimensionless number that combines multiple water-quality factors into a single number by normalizing values to subjective rating curves (Miller *et al*, 1986).Factors to be included in WQI model could vary depending upon the designated water uses and local preferences. Water Quality Indices (WQIs) have been developed to integrate water quality variables (Liou, S., Lo, S., and Wang, S. 2004). WQI summarizes large amounts of water quality data into simple terms (e.g., excellent, good, bad, etc.) for reporting to managers and the public in a consistent manner (Hülya, B. 2009).Purba and Paschim Midnapur is a agriculture base area in West Bengal, India. The population of Midnapur districts has increased from 9968 in 1971 to around 200827 in 2011 but many poor people have live in this districts and suffer different disease due do unhygienic property of water. In view of the above, this paper aims to study the potability and water quality index of different drinking water body in purba and paschim Midnapur.

Materials and methods

1. Collection of water sample

Water samples were collected from nine different water bodies as pond, 121ft,170ft,400ft deep tub well water, Ghatal water (Tank), Ghatal water (Shilabati), Geonkhali water (Before bleaching), Geonkhali water (After bleaching), 70ft shallow water of three selected municipal wards in the month of November, 2021 (Take-1). Samples were collected in plastic bottles for physic-chemical analysis. For Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO), samples were collected in BOD bottles. Temperature and pH of the water was measured at the sampling sites.

Table: 1 - Description of water sampling sites

ıgitude	Latitude	Description	Sites no.
44' 30.7752"E	22° 23' 44.0952" N	near Panskura railway station	S1 (Pond water)
44' 30.7752" E	22° 23' 44.0952" N	near Panskura railway station	S2 (70 ft tw)
44' 30.7752" E	22° 23' 44.0952" N	near Panskura railway station	S3 (121 ft tw)
44' 30.7752" E	22° 23' 44.0952" N	near Panskura railway station	S4 (170ft tw)
44' 30.7752" E	22° 23' 44.0952" N	near Panskura railway station	S5 (400 ft tw)
48.4908 '44 °87	N "49.3056 '39 °22	Near Ghatal municipality tank	S6 (Ghatal)
28' 34.09" E	23° 14' 51.56" N	Near Ghatal silabati river	S7 (Ghatal)
3' 0" E	22° 12' 0" N	Geonkhai (before bleaching)	S8 (Geonkhali)

2. Biochemical analysis of water sample

2.1 Determination of pH

The pH of the surface water was measured with a potable digital pH meter (Model BST-BT-BT65; sensitivity =±0.01). Three readings were recorded from each site and the mean value was considered for statistical analysis.

2.2 Determination of Total Alkalinity (TA), Electrical Conductivity (EC), Total Dissolved Solid (TDS), Total Suspended Solid (TSS) and Total Hardness of water

Alkalinity in water can be determined by titrating the sample using a strong alkali and phenolpthalein used as an indicator (Trivedy and Goel, 1986).Alkalinity (mg/lit) = Volume of 0.1 NHCl solution used as titrant × 1000/ Vol of water sample. Conductance of water was measured by standard conductomete

The hardness of water was measured by titriometric methods using EDTA (Trivedy and Goel, 1986). Hardness as mg/lit or ppm = (V × 20) ppm, Where V= mean volume of EDTA. The total suspended solid, total dissolved solids were analyzed the laboratory as per the standard procedure of APHA (1998).

2.3 Determination of DO, BOD, and COD of water sample

For chemical variables of water like Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) was analyzed by the standard method of APHA(1998) and Trivedy and Goel(1986).

3. Microbial analysis of water sample

3.1 Sampling of the water:

Water samples were collected in sterilized glass container (autoclaved) with utmost care from the selected stations. The collected samples were immediately transferred in ice box and brought to the laboratory for further microbial analysis.

3.2 Determination of total coliform and fecal coliform in water

Fecal coli forms do not pose a health threat but serve as an indicator for bacteria that can cause illness in humans and aquatic life. The total coliform and fecal coliform of water sample was determined multiple fermentation technique by (APHA, 1998).

3.3 Procedure: Presumptive test for total coliform of water:

For the presumptive total coliform test, sodium lauryl tryptose media (broth) was used as culture medium. For analysis of water, five test tubes each of 10 ml, 1 ml and 0.1 ml sample portion were used for the presumptive test. The first set containing five numbers of 10 ml Double Strength (DS) broth tubes. Second and third sets containing ten numbers of 10 ml Single Strength (SS) broth tubes. Each tube in a set of five containing 10 ml, 1ml and 0.1 ml of water samples were inoculated in the first, second and third sets of media tubes respectively and mixed thoroughly. In each case, a control set was also run parallel. The inoculated test tubes were incubated at 36±1˚C. After 24 h, the result for acid and gas production was noted. If there was no gas and acid production then the tubes were re incubated and reexamined at the end of 48 hrs. Within each tube, Durham's tube was inverted placed to show the bacterial growth with emission of gas. Production of gas bubbles and acids with growth was shown in the tubes within 48 hrs contributes a presumptive reaction. After the incubation period of 48 hours, the numbers of positive tubes were counted and proceed for confirmatory test.

3.4 Confirmative test for total coliform:

For confirmative total coliform test, culture medium was used as BGLB broth. The positive presumptive tubes were gently shaken and with a sterile loop (3.0 – 3.5 mm in diameter), one or two loop full of culture was transferred to a test tube containing 10 ml Brilliant Green Lactose Bile broth with an inverted placed Durham's tube. The inoculated Brilliant Green Lactose Bile broth tubes were incubated at 36 ± 1^{0}C. Formation of any gas with growth within 48 hrs constituted the confirmed test. The results were obtained in MPN/100 ml by comparing with standard MPN table.

3.5 Determination of fecal coliform from water:

To enumerate Fecal Coliform (FC), inocula from 24 h positive presumptive tubes were aseptically transferred to tubes of EC medium. These tubes were incubated at 44.0±0.5ºC for 24h and examined for the presence of growth with gas production. Results were expressed as "fecal coliform MPN/100ml".

4. Graphical analysis

Graphical presentation was completed using MS- excel

5. Determination of Water Quality Index (WQI) of water sample

A set of eight most commonly used water quality parameters namely pH, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Total Suspended Solid (TSS) Total Alkalinity (TA), Total Hardness (TH), Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) which together reflect the overall water quality of Panskura municipality, Ghatal municipality and Geonkhali municipality, were selected for generating the Water Quality Index (WQI). Calculation of Water Quality Index was carried out by following the "Weighted Arithmetic Index method" (Brown *et al*, 1970), using the equation: WQI="QnWn./"Wn where Qn is the quality rating of ninth water quality parameter, Wn is the unit weight of ninth water quality parameter. The quality rating Qn is calculated using the equation Qn=100[(Vn-Vi)/(Vs-Vi)] where Vn is the actual amount of the nth water quality parameter present, Vi is the ideal value of the parameter [Vi= 0,except for pH(Vi =7) and DO (Vi= 14.6 mg/l)],Vs is the standard permissible value for the nth water quality parameter. Unit Weight (Wn) is calculated using the formula Wn=k/Vs where is the constant of proportionality and it is calculated using the equation k= [1/"1/ Vs=1,2,….n]. The relative weights (Wn) of the parameters used for WQI is determination is shown in table 1.In general, WQI is defined for a specific and intended use of water. In this study WQI was considered for human consumption or uses and the maximum permissible WQI for the drinking water was taken as 100 score.

The Water Quality Status (WQS) according to WQI is shown in Table 2.

Table 2: Relative weights (Wn) of the parameters used for WQI determination

Parameter	ICMR/BIS standard (Vs)	Unit Weight(Wn)
pH	6.5-8.5	0.215
Electrical conductivity	300	0.0061
TDS	500	0.00366
TSS	500	0.00366
Total Hardness	300	0.0061
DO	5	0.366
BOD	5	0.366
Total Alkalinity	120	0.01525

Σ Wn=0.98. All the parameters are in milligrams per liter except pH and EC (µS/cm)

Result:

Table: 3 Determination of pH, EC, TDS, TA, TSS, TH, DO, BOD, COD

Water sample	pH	Electrical conductivity (EC)(µS /cm)	Total Dissolved Solids (TDS)	Total alkalinity(TA)	Total Suspended Solids (TSS)	Total Hardness (TH)	Dissolved Oxygen (DO)	Biological Oxygen Demand (BOD)	Chemical Oxygen Demand (COD)
Pond(S1)	6.8	0.54	0.03	42	0.06	118	3.2	1.6	256
70ft water (S2)	7.1	0.78	0.01	114.6	0.03	322.6	3.2	0	176
121ft water(S3)	7.3	0.73	0.04	74.6	0.01	230.6	8	2.72	72
170ft water(S4)	7.3	0.70	0.03	82.6	0.04	236	6.8	2	24
400ft water(S5)	7.2	0.46	0.03	66	0.01	192	6.4	0	40
Ghatal water (Tank) S6	6.1	0.38	0.01	58	0.01	166	10.08	3.2	104
Ghatal Water (Silabati)S7	6.9	0.14	0.04	14.6	0.03	66	10.56	3.68	112
Geonkhali water (before bleaching) S8	6.8	0.34	0.01	1.47	0.03	148.6	16	5.44	64
Geonkhali water (After bleaching),S9	7.1	0.36	0.02	28.6	0.07	150.6	13.92	2.24	80

Table-4 Calculation of Water Quality Index in domestic pond water

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	6.8	6.5-8.5	0.2190	13.33	2.91
2	Electrical conductivity	0.54	300	0.371	0.18	0.06
3	Total alkalinity	42	120	0.0155	35	0.54
4	Total Hardness	118	300	0.0062	39.33	0.24
5	Total Dissolved Solids	0.03	500	0.0037	0.006	0.00002
6	Total Suspended Solids	0.06	500	0.0037	0.012	0.00004
7	Dissolved Oxygen	3.2	5.00	0.3723	118.75	44.21
8	Biological Oxygen Demand	1.6	5.00	0.3723	32	11.91
				∑Wn=1.36	∑qn =238.60	∑Wnqn =59.87
Water Quality Index = ∑qnWn/∑Wn =44.02						

Table -5 Calculation of Water Quality Index in 70 ft water

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	7.1	6.5-8.5	0.2190	7	2.91
2	Electrical conductivity	0.78	300	0.371	0.26	0.06
3	Total alkalinity	114.6	120	0.0155	95.5	0.54
4	Total Hardness	322.6	300	0.0062	107.53	0.24
5	Total Dissolved Solids	0.1	500	0.0037	0.02	0.00002
6	Total Suspended Solids	0.03	500	0.0037	0.06	0.00004
7	Dissolved Oxygen	3.2	5.00	0.3723	118.75	44.21
8	Biological Oxygen Demand	0	5.00	0.3723	0	11.91
				∑Wn=1.36	∑qn =329.06	∑Wnqn =48.01
Water Quality Index = ∑qnWn/∑Wn =35.30						

Table-6 Calculation of Water Quality Index in 121 ft water

Sr. No	Parameters	Observe value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	7.3	6.5-8.5	0.2190	20	4.38
2	Electrical conductivity	0.73	300	0.371	0.24	0.08
3	Total alkalinity	74.6	120	0.0155	62.16	0.96
4	Total Hardness	230.6	300	0.0062	76.86	0.47
5	Total Dissolved Solids	0.04	500	0.0037	0.008	0.00002
6	Total Suspended Solids	0.01	500	0.0037	0.002	0.000007
7	Dissolved Oxygen	8	5.00	0.3723	68.75	25.60
8	Biological Oxygen Demand	2.72	5.00	0.3723	54.4	20.25
				∑Wn=1.36	∑qn =282.42	∑Wnqn =51.74
Water Quality Index = ∑qnWn/∑Wn =38.04						

Table-7 Calculation of Water Oualitv Index in 170 ft water

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	73	6.5-8.5	0.2190	20	4.38
2	Electrical conductivity	0.70	300	0.371	0.23	0.08
3	Total alkalinity	82.6	120	0.0155	68.83	1.06
4	Total Hardness	236	300	0.0062	7.86	0.04
5	Total Dissolved Solids	0.03	500	0.0037	0.006	0.00002
6	Total Suspended Solids	0.04	500	0.0037	0.008	0.00002
7	Dissolved Oxygen	6.8	5.00	0.3723	81.25	30.24
8	Biological Oxygen Demand	2	5.00	0.3723	40	14.89
				∑Wn=1.36	∑qn =218.18	∑Wnqn =50.69
Water Quality Index = ∑qnWn/∑Wn =37.27						

Table-8 Calculation of Water Quality Index in 400 ft water

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	7.2	6.5-8.5	0.2190	13.33	2.91
2	Electrical conductivity	0.46	300	0.371	0.15	0.05
3	Total alkalinity	66	120	0.0155	55	0.85
4	Total Hardness	192	300	0.0062	64	0.39
5	Total Dissolved Solids	0.03	500	0.0037	0.006	0.00002
6	Total Suspended Solids	0.01	500	0.0037	0.002	0.000007
7	Dissolved Oxygen	6.4	5.00	0.3723	85.41	31.79
8	Biological Oxygen Demand	0	5.00	0.3723	0	0
				∑Wn=1.36	∑qn =217.89	∑Wnqn =36
Water Quality Index = ∑qnWn/∑Wn =26.47						

Table-9: Calculation of Water Quality Index in Ghatal Municipality tank water

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	6.1	6.5-8.5	0.2190	60	13.14
2	Electrical conductivity	0.38	300	0.371	0.12	0.04
3	Total alkalinity	58	120	0.0155	48.33	0.74
4	Total Hardness	166	300	0.0062	55.33	0.34
5	Total Dissolved Solids	0.01	500	0.0037	0.002	0.000007
6	Total Suspended Solids	0.01	500	0.0037	0.002	0.000007
7	Dissolved Oxygen	10.08	5.00	0.3723	47.08	15.52
8	Biological Oxygen Demand	3.2	5.00	0.3723	64	23.82
				∑Wn=1.36	∑qn =274.86	∑Wnqn =53.60
Water Quality Index = ∑qnWn/∑Wn =39.41						

Table-10 Calculation of Water Quality Index in Ghatal Shilabati

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	6.9	6.5-8.5	0.2190	6.7	1.46
2	Electrical conductivity	0.14	300	0.371	0.04	0.01
3	Total alkalinity	14.6	120	0.0155	12.16	0.18
4	Total Hardness	66	300	0.0062	22	0.13
5	Total Dissolved Solids	0.04	500	0.0037	0.008	0.00002
6	Total Suspended Solids	0.03	500	0.0037	0.006	0.00002
7	Dissolved Oxygen	10.56	5.00	0.3723	42.08	16
8	Biological Oxygen Demand	3.68	5.00	0.3723	73.6	27.40
				∑Wn=1.36	∑qn =157.31	∑Wnqn =45.18
Water Quality Index = ∑qnWn/∑Wn =33.22						

Table-11 Calculation of Water Quality Index in Gneokhali water (After bleaching)

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	7.1	6.5-8.5	0.2190	7	1.53
2	Electrical conductivity	0.36	300	0.371	0.12	0.04
3	Total alkalinity	28.6	120	0.0155	23.83	0.36
4	Total Hardness	150.6	300	0.0062	50.2	0.31
5	Total Dissolved Solids	0.02	500	0.0037	0.004	0.004
6	Total Suspended Solids	0.07	500	0.0037	0.01	0.01
7	Dissolved Oxygen	13.92	5.00	0.3723	7.08	7.08
8	Biological Oxygen Demand	2.24	5.00	0.3723	44.8	44.08
				∑Wn=1.36	∑qn =133.04	∑Wnqn =21.54
Water Quality Index = ∑qnWn/∑Wn =15.83						

Table-12 Calculation of Water Quality Index in Gneokhali water (Before bleaching):

Sr. No	Parameters	Observed value	Standard Values(Sn)	Unit Weight(Wn)	Quality rating(qn)	Wnqn
1	pH	6.8	6.5-8.5	0.2190	13.33	3
2	Electrical conductivity	0.34	300	0.371	0.11	0.04
3	Total alkalinity	1.47	120	0.0155	1.22	0.01
4	Total Hardness	148.6	300	0.0062	49.53	0.30
5	Total Dissolved Solids	0.01	500	0.0037	0.002	0.000007
6	Total Suspended Solids	0.03	500	0.0037	0.006	0.00002
7	Dissolved Oxygen	16	5.00	0.3723	14.58	5.42
8	Biological Oxygen Demand	5.44	5.00	0.3723	108.8	40.50
				$\sum$Wn=1.36	$\sum$qn =187.57	$\sum$Wnqn =49.27
Water Quality Index = $\sum$qnWn/$\sum$Wn =36.22						

Table: 13 WQI value and microbial load of different water sample

Water source	Coli form (MPN/100ml)	Fecal coliform (MPN/100ml)	WQI
Domestic pond water	280	Nil	44.1
70 ft water	17	Nil	35.3
121ft water	2	Nil	38.1
170ft water	26	Nil	37.3
400ft water	11	Nil	26.5
Ghatal municipality tank water	17	Nil	39.4
Ghatal water(Silabati)	2400	02	33.2
Gneokhali water(Before bleaching)	2	Nil	36.2
Gneokhali water(After bleaching)	33	Nil	15.8

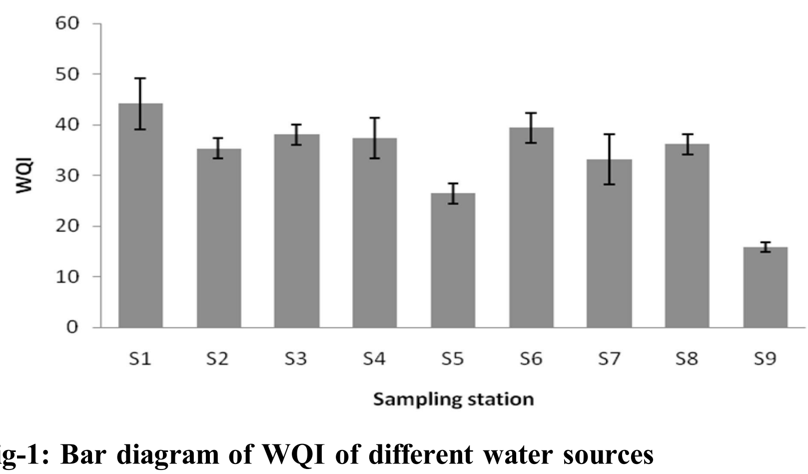

Fig-1: Bar diagram of WQI of different water sources

Discussion:

In this study, the computed grade of WQI values were categorized into five types for human consumption according to (Ramakrishniah *et al*, 2009), as they were revealed in (Table-14).

Table 14: WQI range, status and possible usage of the water sample (Brown *et al*, 1970)

WQI	Water Quality Status	Possible usage
0-25	Excellent	Drinking, irrigation and industrial
26-50	Good	Drinking ,irrigation and industrial
51-75	Poor	Irrigation and industrial
76-100	Very poor	Irrigation
Above 100	Unsuitable for drinking and fish culture	Proper treatment required before use

WQI value indicates the quality of water in terms of index number which represents overall quality of water for any intended use. The mean values of WQI for the calculated water quality index were 44.0, 35.3, 38.0, 37.2, 26.47, 39.4, 33.2, 36.2 and 15.8 for the sampling sites S1, S2, S3 ,S4,S5,S6,S7,S8 and S9 respectively (Table 13). The Water Quality Index (WQI) of all sampling station was calculated by a standard value (table-2) and individual calculation was obtained by table no -4,5,6,7,8,9,10,11 and 12. Microbial profile indicate that the higher coliform load was observed at Silabati river and then domestic pond water which is not suitable for drinking purpose but useful for domestic purpose where as all other water sample are suitable for drinking purpose Table-11). Present result also revealed that all the studied parameter is abnormally differ from permissible level for S7 and S1but other station are within permissible level (Table-3). The index values revealed that the status of the water sample was suitable for human uses in sampling sites S3, S4, S5,S6,S8 and S9 according to WHO guideline standards(Table –14), since they were all in the range good (class 26-50). Thus, a general progressive increase in WQI values for pond water and river water indicated as increase in pollution due to the discharge of various domestic and industries wastewater and also other anthropogenic hazardous waste along the stretch. Therefore, one of the important recommendation outputs of the present study is that the local authority in Purba and Paschim Midnapur district should take this serious issue of water quality degradation in river water and pond water with low depth tube well water. Moreover, there should be a regular or constantly monitoring for the quality of the stream, because this could increase the risk of direct threats to human health and environment, because more pollution could increase the concentrations of unhealthy water pollutants for all organisms.

Conclusion:

Therefore, one of the important recommendation outputs of the present study is that the local authority in Purba and Paschim Midnapur district should take this serious issue of water quality degradation in river water and pond water with low depth tube well water. Moreover, there should be a regular or constantly monitoring for the quality of the stream, because this could increase the risk of direct threats to human health and environment, because more pollution could increase the concentrations of unhealthy water pollutants for all organisms.

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