

Assessment of Water Quality Index of River Gomti Using Weighted Arithmetic Index Method

Nusrat Ali¹, Sh. Runa Oraon², Sh. Aviral Saxsena³

Assistant Professor, Department of Civil Engineering, Integral University, Lucknow, UP, India¹

M. Tech. (Environment) Student, Department of Civil Engineering, Integral University, Lucknow, UP, India^{2,3}

ABSTRACT: River is important for every human being as well as flora and fauna. History shows that important civilization is developed on the bank of River. But due to modern civilization and increase in population, the quality and quantity of river become reduced. It is very necessary to assess the River water quality and subsequently, prepare the mitigation measures to reduced pollution level in River. The present study on Gomti River is to assess the Quality of River Gomti in Lucknow in terms of Water Quality Index and cause of pollution. The Samples were collected at seven locations which include upstream and downstream of Lucknow during March, 2016. The sample collected and analyzed for 10 physio-chemical parameters such as pH, DO, EC, BOD, Total Hardness, Calcium, Magnesium, Chloride, Alkalinity and TDS. The WQI was calculated using Weighted Arithmetic Index Method. The results reveals that at the upstream of Gomti River, Water Quality is moderately polluted (140-150), while traversing to the city, it becomes deteriorate and degrades to severally polluted (217-260) and ultimately it becomes unfit and not suitable for human (more than 300).

KEYWORDS: Weighted Arithmetic Water Quality Index, Gomti River, River Water Quality, Designated Best use of Water

I. INTRODUCTION

With ever growing population and increasing demand of water for food production, industrial and domestic activities increases every year. No doubt, water is essential for life but 99% of the water in the world has been polluted by man-made resources mainly due to rapid urbanization, industrialization and increasing population. Water resources and the quality of water may be insufficient to meet the long-term requirements of consumption, agriculture and other uses unless their judicious and economic uses are ensured. Making the best use of the available water resources involves not only the prevention and control of its depletion and degradation but also managing it in view of the present and future needs is necessary. Chemicals in the form of fertilizers, insecticides used in agricultural fields or industries find their destination into the rivers thus posing a threat to the existing flora and fauna native to these aquatic bodies as well as human health. In addition to the bumper cropped agriculture and dense vegetation, the rapid industrialization and urbanization along the river bank are the supporting pillars of the economic development of this part of the nation. On the other hand environmental degradation is intensely in this area. For a sustainable progress, it is necessary to strike a balance between the two. To manage the environmental degradation, it is mandatory to assess the quality of the river Gomti [1].

The water quality indices are calculated for the following three different uses [3]:

- (a) Drinking Water Quality Index: drinking, recreation, irrigation, and livestock watering uses.
- (b) Aquatic Water Quality Index: aquatic life and wildlife protection uses.
- (c) Overall Water Quality Index: all uses including the protection of human health, aquatic ecosystems, wildlife etc.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

The determination of the water quality index is based on the following three major factors [3]:

1. The number of objectives that are not met.
2. The frequency with which the objectives are not met.
3. The magnitude by which the objectives are not met.

Water Quality Index by Weighted Arithmetic Method[4]:

In order to calculate the Water Quality Index, all the 10 physico-chemical parameters have been utilized.

The Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index method. The quality rating scale for each parameter q_i was calculated by using this expression:

$$Q_i = (C_i/S_i) \times 100$$

A quality rating scale (Q_i) for each parameter is assigned by dividing its concentration (C_i) in each water sample by its respective standard (S_i) and the result multiplied by 100.

Relative weight (W_i) was calculated by a value inversely proportional to the recommended standard (S_i) of the corresponding parameter:

$$W_i = 1/S_i$$

Overall Water Quality Index (WQI) was calculated by aggregating the quality rating (Q_i) with unit weight (W_i) linearly:

$$WQI = (\sum W_i Q_i)$$

Generally, WQI were discussed for a specific and intended use of water. In this study the WQI for drinking purposes is considered and permissible WQI for the drinking water is taken as 100:

$$\text{Overall WQI} = (\sum W_i Q_i) / \sum W_i$$

Using the water quality index, all the samples were categorized into the following five classes: excellent (<50), Good (50 - 100), moderately polluted (100 - 200), severely polluted (200 - 300) and unfit for human consumption (above 300) based on their suitability. $50 < WQI < 300$ indicates that the water is fit for human use and $50 > WQI > 300$ reflects its unsuitability for use [4].

II. STUDY AREA

River Gomti, a tributary of holy River Ganga is an important river of Uttar Pradesh and is also life line of capital Lucknow. River Gomti also called as Adi Ganga is a daughter of Sage Vashisth. River Gomti is a tributary of River Ganga. The Gomti originates from natural impounding reservoir near madho taal (Phoolar Jheel), Pilibhit, India. It traverses a distance 900 Kms (560 miles) through Uttar Pradesh before it joins the River Ganga near Adiyar (Saidpur Kaithi) in the district of Ghazipur (U.P.). The river contributes about 15 % of the flow of River Ganga. River Gomti has an average dry weather flow of 1500MLD, while in monsoon season the flow becomes very as high as 55,000 MLD and in summer as low as 500 MLD. River Gomti has an effective area of about 25, 735 sq.km.

The river flows as a rivulet until it reaches Mohamadi (about 100 K from its origin) where it is joined by the river Sarayan a prominent tributary. From here the river is well defined. Another major tributary is the Sai River, which joins near Jaunpur.

Like many other rivers it is also facing problems of pollution due to discharge of sewage and industrial effluents. Before reaching in Lucknow Gomti receives waste from Sugar, Pulp & Paper, Textiles and Distillery industries of Lakhimpur Khiri & Sitapur. After travelling about 240 kms, the river Gomti enter Lucknow, through which it meanders about 15 kms. At the entrance point in Lucknow i.e. at Gau Ghat 280 MLD of water is lifted from river for the city's water supply. 26 city drains empty themselves in to River Gomti. At the downstream (Near Gomti Nagar) the Gomti barrage impounds the river converting it into a lake.

The cities of Lucknow, Sultanpur and Jaunpur located on the banks of the river Gomti, are the most prominent of the 15 towns located in its catchment area.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

The sample was collected from the seven locations at Lucknow. The sample were collected from Manjhi Ghat, Upstream water intake, Kuriyaghat, Downstream Mohan Meakins, Downstream Nishat Ganj, Upstream Barrage and Downstream after STP Bharwara.

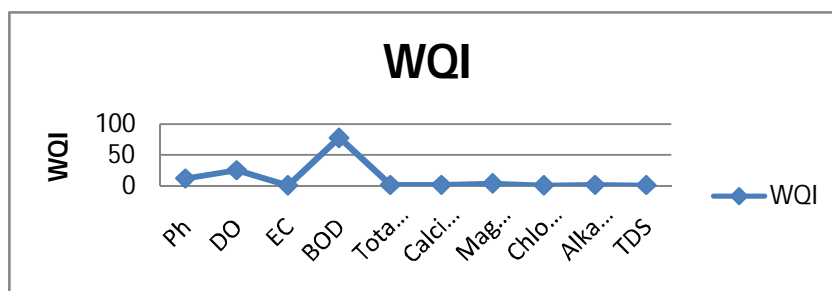
III. RESULTS AND DISCUSSION

The samples collected, analyzed and WQI was calculated using Weighted Arithmetic Mean. The analysis results of sample collected at Manjhi Ghat is depicted in Table-1.

The analysis results reveal exceeding the values of BOD, Total Hardness and Alkalinity with the standard value. However, the value of DO is very good. The Gomti River Water at this location may be classified as Class-C based on CPCB guidelines for Designated Best Use of Water [2].

Table-1

Sampling Locations: Manjhi Ghat							
Parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI
pH	--	8.25	6.5-8.5	6.5-8.5	97.05	0.117	11.35485
DO	mg/l	8.9	5	6	148.3	0.166	24.62278
EC	$\mu\text{S}/\text{cm}^2$	560.2	-	2250	24.8	0.000	0.00992
BOD	mg/l	3.1	-	2	155	0.500	77.5
Total Hardness	mg/l	220	200	-	110	0.005	0.55
Calcium	mg/l	41.6	75	-	55.46	0.013	0.72098
Magnesium	mg/l	27.84	30	-	92.8	0.033	3.0624
Chloride	mg/l	15	250	-	6	0.004	0.024
Alkanity	mg/l	244	200	-	122	0.005	0.61
TDS	mg/l	332	500	-	66.4	0.002	0.1328
						0.845	118.59
							Overall WQI= 140.27



The WQI at this location is calculated as 140.27, which indicate moderately pollution of water. The cause of pollution at this location is generally due to the sewage and industrial discharge on the upstream of Lucknow.

The analysis results of sample collected at Upstream water intake point is depicted at Table-2.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

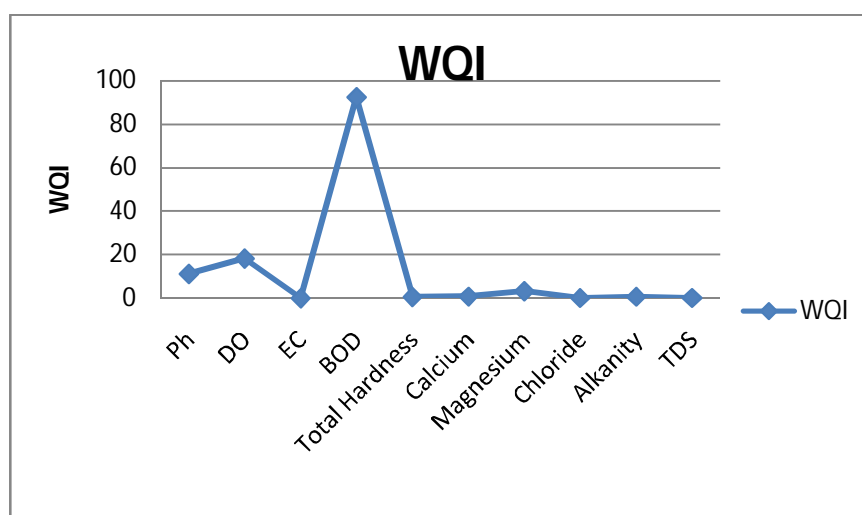
Table-2

Sampling Locations: Upstream water intake

parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI
pH	--	8.14	6.5-8.5	6.5-8.5	95.76	0.117	11.20392
DO	mg/l	6.6	5	6	110	0.166	18.26
EC	μS/cm ²	582.4	-	2250	25.88	0.0004	0.010352
BOD	mg/l	3.7	-	2	185	0.5	92.5
Total Hardness	mg/l	232	200	-	116	0.005	0.58
Calcium	mg/l	44	75	-	58.66	0.013	0.76258
Magnesium	mg/l	29.28	30	-	97.6	0.033	3.2208
Chloride	mg/l	17	250	-	6.8	0.004	0.0272
Alkanity	mg/l	252	200	-	126	0.005	0.63
TDS	mg/l	346	500	-	69.2	0.002	0.1384
						0.8454	127.3333

Overall
WQI=150.61

The analysis results reveals reduction of DO and increase in BOD from Manjhi Ghat. The analysis results reveals exceeding the values of BOD, Total Hardness and Alkalinity with the standard value. However, the value of DO is good. The Gomti River Water at this location may be classified as Class-C based on CPCB guidelines for Designated Best Use of Water.



The WQI at this location is calculated as 150.61, which indicate moderately pollution of water. The cause of pollution at this location is generally due to the sewage discharge.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

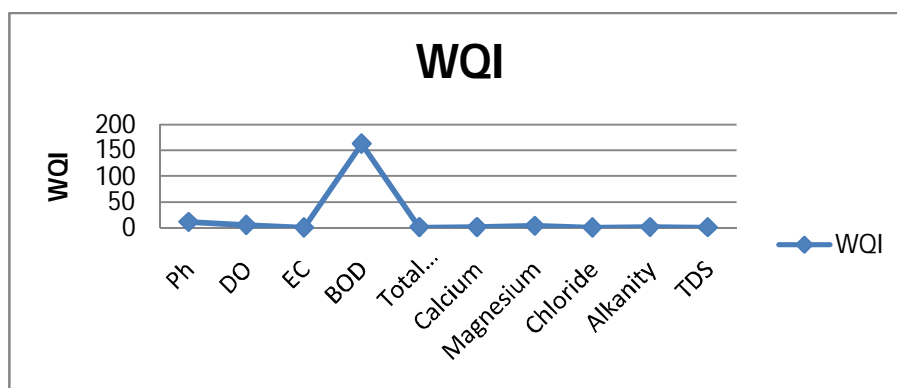
Vol. 5, Issue 5, May 2016

The analysis results of sample collected at Kuriya Ghat is depicted at Table-3.

Table-3

Sampling Locations: Kuriya Ghat							
parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI
pH	--	7.75	6.5-8.5	6.5-8.5	91.17	0.117	10.66689
DO	mg/l	1.8	5	6	30	0.166	4.98
EC	$\mu\text{S}/\text{cm}^2$	738.2	-	2250	32.8	0.0004	0.01312
BOD	mg/l	6.5	-	2	325	0.5	162.5
Total Hardness	mg/l	242	200	-	121	0.005	0.605
Calcium	mg/l	46.4	75	-	61.86	0.013	0.80418
Magnesium	mg/l	30.24	30	-	100.8	0.033	3.3264
Chloride	mg/l	21	250	-	8.4	0.004	0.0336
Alkanity	mg/l	260	200	-	130	0.005	0.65
TDS	mg/l	424	500	-	84.8	0.002	0.1696
						0.8454	183.7488
Overall							217.35

Kuriya Ghat is important religious place in Lucknow. The analysis results reveals significant increase in BOD and reduction in DO. The analysis results also reveals exceeding the values of Total Hardness and Alkalinity with the standard value. Kuriya Ghat is used for human bathing as well and cloth washing (Dhobighat). Hence, however, the value of DO is good. The Gomti River Water at this location may be classified as Class-C based on CPCB guidelines for Designated Best Use of Water.



The WQI at this location is calculated as 150.61, which indicate moderately pollution of water. The cause of pollution at this location is generally due to the sewage discharge.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

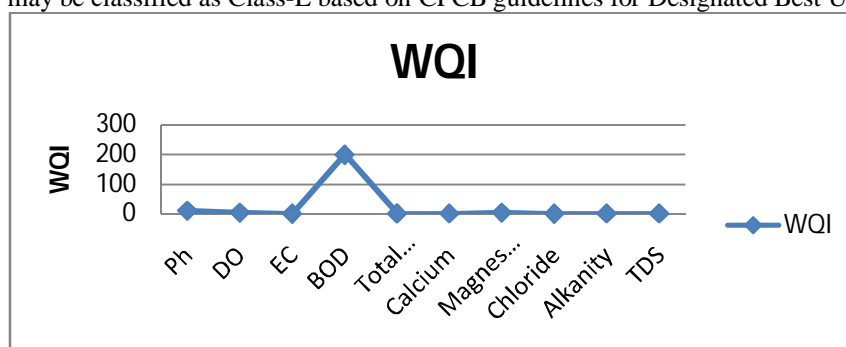
Vol. 5, Issue 5, May 2016

The analysis results of sample collected at Mohan Meakins is depicted at Table-4.

Table-4

Sampling Locations: Downstream Mohan Meakins							
parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI
pH	--	7.63	6.5-8.5	6.5-8.5	89.76	0.117	10.50192
DO	mg/l	1.5	5	6	25	0.166	4.15
EC	$\mu\text{S}/\text{cm}^2$	763.7	-	2250	33.9	0.0004	0.01356
BOD	mg/l	8	-	2	400	0.5	200
Total Hardness	mg/l	250	200	-	125	0.005	0.625
Calcium	mg/l	48	75	-	64	0.013	0.832
Magnesium	mg/l	31.2	30	-	104	0.033	3.432
Chloride	mg/l	22	250	-	8.8	0.004	0.0352
Alkanity	mg/l	266	200	-	133	0.005	0.665
TDS	mg/l	438	500	-	87.6	0.002	0.1752
						0.8454	220.4299
Overall WQI							260.42

The analysis results reveals significant increase in BOD and reduction in DO. The analysis results also reveals exceeding the values of Total Hardness and Alkalinity with the standard value. Due to this, the Gomti River Water at this location may be classified as Class-E based on CPCB guidelines for Designated Best Use of Water.



The WQI at this location is calculated as 260.42, which indicate severally pollution of water. The cause of pollution at this location is generally due to the sewage discharge.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

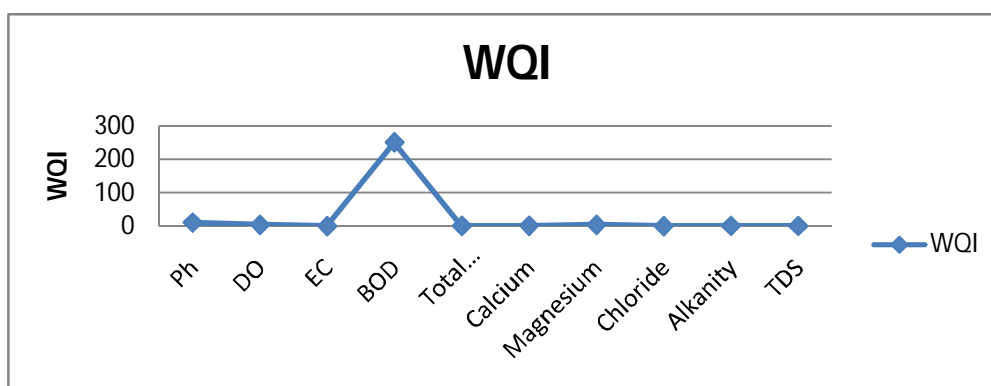
Vol. 5, Issue 5, May 2016

The analysis results of sample collected at Downstream of Nishatganj is depicted at Table-5.

Table-5

Sampling Locations: Downstream Nishat Ganj								
parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI	
pH	---	7.57	6.5-8.5	6.5-8.5	89.05	0.117	10.41885	
DO	mg/l	1.2	5	6	20	0.166	3.32	
EC	μS/cm ²	797	-	2250	35.42	0.0004	0.014168	
BOD	mg/l	10	-	2	500	0.5	250	
Total Hardness	mg/l	260	200	-	130	0.005	0.65	
Calcium	mg/l	49.6	75	-	66.13	0.013	0.85969	
Magnesium	mg/l	32.64	30	-	108.8	0.033	3.5904	
Chloride	mg/l	24	250	-	9.6	0.004	0.0384	
Alkanity	mg/l	278	200	-	139	0.005	0.695	
TDS	mg/l	456	500	-	91.2	0.002	0.1824	
						0.8454	269.7689	
Overall WQI								319.1

The analysis results reveals significant increase in BOD and reduction in DO. The analysis results also reveals exceeding the values of Total Hardness, Magnesium and Alkalinity with the standard value. Due to this, the Gomti River Water at this location may be classified as Class-E based on CPCB guidelines for Designated Best Use of Water.



The WQI at this location is calculated as 319.1, which indicate unfit for human. The cause of pollution at this location is generally due to the sewage discharge.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

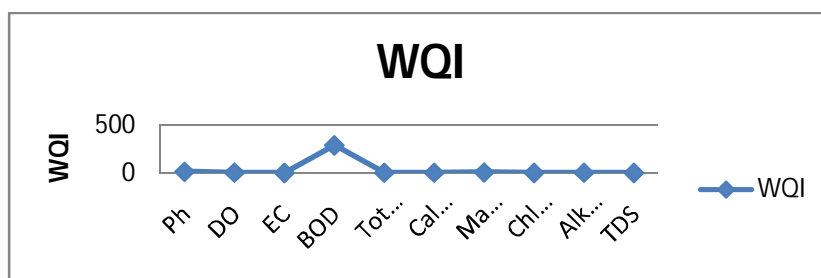
Vol. 5, Issue 5, May 2016

The analysis results of sample collected at upstream Barrage is depicted at Table-6.

Table-6

Sampling Locations: Up- stream Barrage							
parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI
pH	---	7.53	6.5-8.5	6.5-8.5	88.58	0.117	10.36386
DO	mg/l	0.8	5	6	13.3	0.166	2.2078
EC	μS/cm ²	803.6	-	2250	35.71	0.0004	0.014284
BOD	mg/l	11.5	-	2	575	0.5	287.5
Total Hardness	mg/l	266	200	-	133	0.005	0.665
Calcium	mg/l	51.2	75	-	68.26	0.013	0.88738
Magnesium	mg/l	33.12	30	-	110.4	0.033	3.6432
Chloride	mg/l	26	250	-	10.4	0.004	0.0416
Alkanity	mg/l	282	200	-	141	0.005	0.705
TDS	mg/l	464	500	-	92.8	0.002	0.1856
						0.8454	306.2137
Overall WQI							362.21

The analysis results reveals significant increase in BOD and reduction in DO. The analysis results also reveals exceeding the values of Total Hardness, Magnesium and Alkalinity with the standard value. Due to this, the Gomti River Water at this location may be classified as Class-E based on CPCB guidelines for Designated Best Use of Water.



The WQI at this location is calculated as 362.21, which indicate unfit for human. The cause of pollution at this location is generally due to the sewage discharge.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

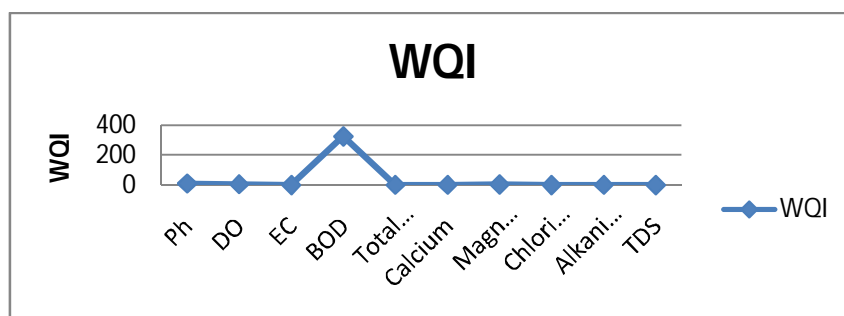
Vol. 5, Issue 5, May 2016

The analysis results of sample collected at Downstream after meeting STP Bharwara is depicted at Table-7

Table-7

Sampling Locations: Downstream after meeting STP Bharwara							
parameters	Unit	Value(Q)	Standard as per BIS 10500:2012	Standard as per CPCB	Q1	W1	WQI
pH	--	7.49	6.5-8.5	6.5-8.5	88.11	0.117	10.30887
DO	mg/l	1.8	5	6	30	0.166	4.98
EC	µS/cm ²	855.9	-	2250	38.04	0.0004	0.015216
BOD	mg/l	13	-	2	650	0.5	325
Total Hardness	mg/l	278	200	-	139	0.005	0.695
Calcium	mg/l	52.8	75	-	70.4	0.013	0.9152
Magnesium	mg/l	35.04	30	-	116.8	0.033	3.8544
Chloride	mg/l	29	250	-	11.6	0.004	0.0464
Alkanyity	mg/l	296	200	-	148	0.005	0.74
TDS	mg/l	496	500	-	99.2	0.002	0.1984
						0.8454	346.7535
Overall WQI							410.16

The analysis results reveals significant increase in BOD and reduction in DO. However, DO is better from the sample collected from upstream of Gomti Barrage but BOD increases. The analysis results also reveals exceeding the values of Total Hardness, Magnesium and Alkalinity with the standard value. Due to this, the Gomti River Water at this location may be classified as Class-E based on CPCB guidelines for Designated Best Use of Water.



The WQI at this location is calculated as 410.16, which indicate unfit for human. The cause of pollution at this location is generally due to the sewage discharge.

IV. CONCLUSION

The Assessment of Water Quality Index using Weighted Arithmetic Method reveals that the quality of River Gomti is deteriorating while entering into Lucknow city due to the discharge of huge quantity of sewage through different drain into River Gomti. The quality of river water was moderately polluted at the entrance of the city (Manjhi Ghat and Water intake point) and pollution at this point is mainly found due to some industrial as well as domestic discharge into

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

River. The river water quality is classified as Class-C at this point. Thus, water is used for supply into Lucknow City. But, river water quality deteriorate after entering into City due to sewage discharge and it is classified as Class-E. It is necessary to tap all drains carrying sewage leading to River Gomti and treated it into STPs. Treated sewage may either be discharged into River Gomti or it can be used for irrigation.

REFERENCES

1. Saha1, P. D., Sengupta1, R., Saha2, J. and Banerjee2, P. K. "Assessment on the water quality characteristics of River Ganga at Kolkata Region, India using Water Quality Index and ANN simulation method.", ARCH. ENVIRON. SCI. (2012), 6, 34-41
2. http://cpcb.nic.in/Water_Quality_Criteria.php.
3. 'Water Quality Index Applied to the Exploit River Watershed', Department of Environment Water Resource Management Division, 4th Floor, Confederation Building, West Block, P.O.Box 8700, St. John's NF
4. Yisa, J. and Jimoh, T." Analytical Studies on Water Quality Index of River Landzu", American Journal of Applied Sciences 7 (4): 453-458, 2010
5. Bureau of Indian Standards for Drinking Water(IS 10500:2012)