2020-21

REPORT ON WATER QUALITY OF RIVER YAMUNA, PRE AND POST IDOL IMMERSION ON GANESH CHATURTHI AND DURGA PUJA, 2021







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Chapter 1

Introduction

1.1 Background

Ganesh Chaturthi, also called Vinayaka Chaturthi and Durga Puja are auspicious Hindu festivals which are celebrated for several days every year. During these festivals, idols are worshipped and immersed in nearby water bodies by the devotees. The idols generally made up of clay, Plaster of Paris (POP), plastic, cement etc. are painted with inorganic paints/ colours. When the idols are immersed into water bodies, it is likely to contaminate the water bodies by dissolving the heavy metals and degrading the water quality of the water body.

During recent years, there has been availability of substitute materials for idol making, safe disposal measures and environment friendly decorative items. Increased use of Plaster of Paris (PoP) based idols, use of dyes containing toxic metals, plastic and thermocol accessories for decoration and immersion of such idols in water bodiescause pollution. Considering the orders passed by Hon'ble Court, a need was felt to revise guidelines issued in the year 2010 for idol immersion and subsequently, "Revised Guidelines for Idol immersion" was issued during May, 2020 effective from 01.01.2021.

Further, Hon'ble NGT in the matter of OA No. 06/2012- Manoj Mishra Vs Union of India & Ors and connected matters pronounced various directions in respect of any type of visarjan in river Yamuna (an important tributary of river Ganga) vide orders dated 13.01.2015 and 16.09.2015. These orders prohibit throwing Puja material or any other material like idols, flowers, havan samagri, food grain, oil etc. into river Yamuna except at the designated sites. Any person who is found disobeying this direction shall be liable to pay compensation of Rs. 5000/- on the "Polluter pays principle".

In Delhi, immersion of Idols was prohibited in River Yamuna during 2019 and artificial ponds were created by concerned State govt departments. To analyse the impact on water quality of river Yamuna locations due to non-immersion of idols, CPCB has conducted sampling and analysis during pre and post Puja season at both the occasions of Ganesh Chaturthi and Durga Puja in previous years.

Water quality monitoring on river Yamuna was carried out by CPCB to assess the impact of idol immersion activity during Ganesh Chaturthi and Durga Puja festivals in the year 2021.

1.2 Sampling Plan

Two teams were constituted comprising CPCB officials for monitoring and sampling of water quality at 06 different locations on River Yamuna in Delhi during pre and post idol immersion during Ganesh Chaturthi & Durga Puja in 2021. The location map and sampling location details are given in **Figure 1** and **Table 1**, respectively.

Water quality monitoring and sampling was conducted at 06 locations/ ghats of river Yamuna covering a stretch of nearly 37 km out of which nearly 22 km were in Delhi and 15 km in Uttar Pradesh till Asgarpur, Okhla D/s. Ghats on river Yamuna were selected as sampling sites because impact of idol immersion activity have been observed during puja season in previous years. River Yamuna locations were also selected because major drains outfall at these locations impact the water quality of the river Yamuna in Delhi.

Analysis of collected samples were carried out for water quality parameters viz. pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Fecal Coliform (FC) and Heavy Metals such as Arsenic (As), Cadmium (Cd), Cobalt (Co), Copper (Cu), Chromium (Cr), Iron (Fe), Manganese (Mn), Nickel (Ni), Lead (Pb), and Zinc (Zn).

The analysis results for the parameters such as pH, Dissolved Oxygen (DO), Bio-Chemical Oxygen Demand (BOD) and Fecal Coliform (FC) were compared with the Primary Water Quality Criteria (PWQC) for Outdoor Bathing notified under Environment (Protection) Rules, 1986 by Ministry of Environment, Forest & Climate change (MoEF&CC) (Annexure V).



Fig. 1 Sampling locations on River Yamuna in Delhi (Pre and Post Ganesh Chaturthi & Durga Puja).

 Table 1: Details of sampling locations on River Yamuna in Delhi.

				Date of Monitoring		
S No	Location	Latitudo	Longitudo	Pre-	Post-	Parameters monitored
5.INU	Location	Latitude	Longhude	immersion	immersion	
1	Palla	28.870365 N	77.209211 E			Physicochemical
						Parameters* - pH, DO
2	Sur Ghat	28.710316 N	77.230966 E	Ganesh	Ganesh	(mg/L), BOD (mg/L)
				Chaturthi-	Chaturthi-	Bactoriological
3	ITO Bridge	28.627163 N	77.253504 E	10.09.2021		narameter-Fecal
					20.09.2021	Coliform (MPN/100 mI)
4	Nizamuddin	28.598582 N	77.263308 E			
				Durga	Durga	Heavy Metals (mg/L)-
5	Okhla bridge	28.543245 N	77.3135360 E	Puja-	Puja-	Arsenic, Cadmium,
	at Kalindi			13.10.2021	,	Cobalt, Copper,
	Kunj				16.10.20	Chromium, Iron,
6	Asgarpur.	28.517811 N	77.34360 E		21	Manganese, Nickel, Lead,
	Okhla D/s					Zinc

*All parameters except pH and Fecal Coliform are measured in mg/L

Chapter 2

Water Quality of River Yamuna, Pre and Post-Idol Immersion during Ganesh Chaturthi, 2021

Ganesh Chaturthi festival was celebrated on 10.09.2021 and concluded (visarjan) on 21.10.2021. The water quality monitoring was carried out on selected locations on River Yamuna & ghats during pre-idol immersion (10.09.2021) and post idol immersion (20.09.2021). The photographs of the sampling locations on River Yamuna are presented below: -

Pre-Idol immersion (10.09.2021)



Figure 2: River Yamuna at Palla



Figure 4: River Yamuna at ITO Bridge



Figure 3: River Yamuna at Surghat



Figure 5: River Yamuna at Nizamuddin



Figure 6: River Yamuna at Okhla bridge at Kalindi Kunj



Figure 7: River Yamuna at Asgarpur, Okhla D/s

Figure 2-7 - The photographs of the sampling locations on river Yamuna during 10.09.2021 (Pre-idol immersion)

Post-Idol immersion (20.09.2021)



Figure 8: River Yamuna at Palla



Figure 9: River Yamuna at Surghat



Figure 10: River Yamuna at ITO Bridge



Figure 12: River Yamuna at Okhla bridge at Kalindi Kunj



Figure 11: River Yamuna at Nizamuddin



Figure 13: River Yamuna at Asgarpur, Okhla D/s

Figure 8-13 - The photographs of the sampling locations on river Yamuna during 20.09.2021 (Post-idol immersion)

2.1 Analytical Results

Analysis results of samples collected during pre-immersion and post-Idol Immersion of Ganesh Chaturthi, are tabulated in **Table 2 & 3**.

Table 2: Analysis results (Physico-Chemical and Bacteriological Parameter) of Yamuna River water samples monitored at immersion ghats during pre and post-idol immersion activity during Ganesh Chaturthi (10.09.2021 and 20.09.2021)

S N	Sampling location	Date of sampling	Pre/ Post immersion sampling	рН	DO (mg/L)	BOD (mg/L)	Fecal Coliform (MPN/ 100 ml)
Prim	ary Water Qu	ality Criteria	for Outdoor	6.5- 8 E	>5 ma/I	<3 ma/I	<2500 MPN/
Dath	Dalla	10.00.2021	Due	0.5		mg/L	100 mi
	Palla	10.09.2021	Pre	7.9	4.9	6	22 × 10 ³
1		20.09.2021	Post	8.3	3.71 🖊	7	13×10^{3}
	Surghat	10.09.2021	Pre	8.1	5.2	5	17×10^{3}
2		20.09.2021	Post	8.1	6.7 🚺	2 🗸	35 × 10 ³ 🚺
	ITO Bridge	10.09.2021	Pre	7.5	BDL	11	16×10^{6}
3		20.09.2021	Post	7.9	2.25 🕇	7 🗸	35 × 106 🕇
	Nizamuddin	10.09.2021	Pre	7.5	BDL	12	33×10^{5}
4		20.09.2021	Post	7.8	BDL	6 🖡	21 × 105 🦊
	Okhla bridge	10.09.2021	Pre	7.5	BDL	13	68×10^{4}
5	at Kalindi	20.09.2021	Post	7.6	6.03 🛖	8	27× 104
	Kunj					•	•
	Okhla D/S,	10.09.2021	Pre	7.6	BDL	12	92×10^{6}
6	Asgarpur	20.09.2021	Post	7.7	5.32 🚺	6 🖡	61 × 104 🦊

Note (i) - pH, DO, BOD have been compared with Primary Water Quality Criteria for Outdoor Bathing notified under Environment (Protection) Rules, 1986 by Ministry of Environment, Forest & Climate Change (MoEF&CC).

(ii) - BDL for DO- (0.3 mg/L), BOD- (1 mg/L) and FC- (<1.8 MPN/100 ml).

(*iii*) - ↑ and ↓ indicate increase or decrease in parameters concentration.

Post-immersion
 No exceedance observed in pH value DO meeting the criteria at 03 out of 06 monitored locations. BOD is meeting the criteria at one out of 06 monitored locations i.e., at Surghat. Fecal Coliform does not meet the criteria at any of the 06 monitored locations

Note (iv) - Graphical representation of parameters DO, BOD & FC during pre & post immersion during Ganesh Chaturthi in Delhi given at Annexure I.

Table 3: Analysis results of Heavy Metals of water samples of river Yamuna & immersion ghats monitored during pre and post-idolimmersion activity during Ganesh Chaturthi (10.09.2021 and 20.09.2021)

S	s Pre/Post				Heavy Metals (mg/L)								
N	Sampling Location Details	Sampling Date	Idol Immersion Sampling	As	Cd	Со	Cr	Cu	Fe	Mn	Ni	Pb	Zn
1	Palla	10.09.2021	Pre	BDL	BDL	BDL	BDL	BDL	1.53	0.18	BDL	BDL	0.02
1.	1 ana	20.09.2021	Post	BDL	BDL	BDL	0.01	0.02	6.98	0.27	0.01	BDL	0.05
2	Curreleat	10.09.2021	Pre	BDL	BDL	BDL	BDL	BDL	1.27	0.18	BDL	BDL	0.02
∠.	Juighat	20.09.2021	Post	BDL	BDL	BDL	0.02	0.02	13.03	0.38	0.02	BDL	0.07
3	ITO Bridge	10.09.2021	Pre	BDL	BDL	BDL	0.01	BDL	0.77	0.54	0.01	BDL	0.03
0.	iio bilage	20.09.2021	Post	BDL	BDL	BDL	0.01	BDL	3.26	0.36	BDL	BDL	0.05
4	NT: 11:	10.09.2021	Pre	BDL	BDL	BDL	BDL	BDL	0.72	0.47	BDL	BDL	0.03
4.	Nizamuddin	20.09.2021	Post	BDL	BDL	BDL	0.02	0.02	8.68	0.39	0.02	0.01	0.11
5	Okhla bridge at	10.09.2021	Pre	BDL	BDL	BDL	BDL	BDL	0.64	0.39	BDL	BDL	0.03
0.	Kalindi Kunj	20.09.2021	Post	BDL	BDL	BDL	0.01	0.01	7.53	0.37	0.01	BDL	0.05
6	Asgarpur Okhla D/s	10.09.2021	Pre	BDL	BDL	BDL	BDL	BDL	0.56	0.42	BDL	BDL	0.06
6.	115garpur, Okilla D/S	20.09.2021	Post	BDL	BDL	BDL	0.01	0.01	4.55	0.37	0.01	BDL	0.05

Note (i) - BDL-Below Detection Limit (mg/L): As-0.00049, Cd- 0.00042, Co- 0.00035, Cr-0.00056, Cu- 0.00035, Fe- 0.00067, Mn- 0.00043, Ni -0.00054, Pb -0.00031 & Zn 0.00059

(ii) - \uparrow and \downarrow indicate increase or decrease in parameters concentration.

Pre-immersion		Post	-immersion	
• Aresenic, Cadmium, Cobalt, Copper	•	Aresenic,	Cadmium,	Cobalt,
and Lead observed 'BDL' at all the		observed 'H	BDL' at all the r	nonitored
monitored locations.		locations.		

2.2 Observations

Based on the water quality assessment at 06 monitored locations in Delhi, carried out during pre and post idol immersion activity of Ganesh Chaturthi, the observations are given below: -

2.2.1 Pre-idol immersion

The analysis results reveal the following: -

- pH was observed in the range of 7.5 to 8.1 at all the locations.
- Dissolved Oxygen (DO) was complying to the criteria (>5 mg/L) only at one location i.e., Surghat (5.2 mg/L).
- BOD (< 3 mg/L) and Fecal Coliform (< 2500 MPN/ 100 ml) were noncomplying to the criteria at all the 06 monitored locations.
- Arsenic (As), Cadmium (Cd), Cobalt (Co), Copper (Cu) and Lead (Pb) concentration observed as 'BDL' at all the monitored locations.
- Iron was observed in the range of 0.56- 1.53 mg/l, Manganese (Mn) was observed in range 0.18- 0.54 mg/L, Chromium and Nickel observed in the range BDL- 0.01 mg/L and Zinc was observed in the range 0.02- 0.06 mg/L.

2.2.2 Post-idol immersion

The analysis results reveal the following: -

• pH was in the range of 7.6 to 8.3 at all the monitored locations.

- Dissolved Oxygen (DO) was complying at 03 locations (Surghat, Okhla bridge at Kalindi Kunj and Asgarpur, Okhla D/s).
- BOD was meeting with the criteria at one monitored location (Surghat).
- Fecal coliform concentration was not complying with the criteria (<2500 MPN/100 ml) at all the 06 monitored locations.
- Arsenic (As), Cadmium (Cd), and Cobalt (Co) concentration observed to be 'BDL' at all the monitored locations.
- Chromium observed in the range 0.01- 0.02 mg/L, Iron in the range 3.26- 13.03 mg/L, Manganese in the range 0.27-0.39 mg/L, Copper and Nickel in the range BDL- 0.02 mg/L, Lead in the range BDL- 0.01 mg/L and Zinc observed in the range 0.05- 0.11 mg/L.

2.2.3 Conclusion

The above findings clearly indicate that at most of the monitored locations during idol immersion activity:

- pH remained within the limit at all the monitored locations.
- During pre and post-immersion, DO remained NIL at 04 out of 06 monitored locations. DO was meeting the criteria at Surghat during both pre and post immersion activity and at Okhla bridge at Kalindi Kunj and Asgarpur, Okhla D/s during post immersion. However, increased at 4 out of 6 locations during post immersion.
- BOD concentration was decreasing at 5 out of 6 monitored locations during post immersion activity. Highest BOD was observed at Okhla bridge at Kalindi Kunj (13 mg/L) pre immersion.
- Fecal Coliform concentration was not complying with the criteria at all monitored locations however, decreased at 04 out of 06 monitored locations during post immersion.

• Increase in metal concentration observed during post-immersion activity may be attributed to agitation in river bed due to the rains in monsoon season.

Note: Graphical representations for comparison of pre and post analysis of heavy metals is given at Annexure II.

Chapter 3

Comparative Study of water quality during Idol Immersion-Ganesh Chaturthi, 2020 vs. 2021

Comparative study of analytical results of water quality observed during Ganesh Chaturthi Idol Immersion activity of 2020 vs. 2021 with respect to pre and post idol immersion for physico-chemical, bacteriological parameter and heavy metals at all monitored locations of River Yamuna in Delhi, as given in **Table 4 and Table 5**:

Table 4: Comparison of General and Bacteriological parameter of Water Quality of Yamuna River during pre and post-idol immersion during Ganesh Chaturthi in previous year (2020) and present year (2021)

	Vorrof			P	arameters	
S1. N	Monitoring	Duration	лЦ	DO	BOD	Fecal Coliform
	Wollitoning		рп	(mg/L)	(mg/L)	(MPN/ 100mL)
Water Quality Criteria		6.5-8.5	>5 mg/L	<3 mg/L	<2500 MPN/100ml	
1	2020	Pre (26.08.2020)	7.6-7.7	0.5-6.6	4.8-9.9	
1.	2020	Pre (27.08.2020)	7.6-7.9	0.5 - 6	3.1-9.7	
2.	2021	Pre (10.09.2021)	7.5-8.1	BDL- 5.2	5- 13 1	17×10 ³ - 92×10 ⁶
3.	2020	Post (01.09.2020)	7.5-7.7	1.2-7.2	6.6-18	
4.	2021	Post (20.09.2021)	7.6-8.3	BDL-6.7	2-8 🗸	13×10 ³ - 35×10 ⁶

Note (i) - pH, DO, BOD have been compared with Primary Water Quality Criteria for Outdoor Bathing notified under Environment (Protection) Rules, 1986 by Ministry of Environment, Forest & Climate Change (MoEF&CC).

(ii) - BDL for DO- (0.3 mg/L), BOD- (1 mg/L) and FC-(<1.8 MPN/100 ml).

(iii) - \uparrow and \downarrow indicate increase or decrease in parameters concentration.

Table 5: Comparison of Range of Heavy metal	s in previous	year (2020) and p	resent
year (2021) during Ganesh Chaturthi				

c	Year of		Parameters							
J.	Monito	Duration	Cr	Cu	Fe	Ni	Pb	Zn		
1	ring		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)		
1	2020	Pre (26.08.2020)	BDL-0.02	BDL-0.02	1.10-19.03		BDL-0.02	0.02-0.06		
1.	2020	Pre (27.08.2020)	BDL-0.02	BDL-0.01	3.01 -9.86		BDL 🖊	0.03-0.08		
2.	2021	Pre (10.09.2021)	BDL-0.01	BDL 🦊	0.56- 1.53	BDL-0.01	BDL	0.02-0.06		
3.	2020	Post (01.09.2020)	0.02-0.05	BDL-0.02	5.20-15.89		BDL-0.01	0.04-0.12		
4.	2021	Post (20.09.2021)	0.01-0.02	BDL-0.02	3.26-13.03	BDL-0.02	BDL-0.01	0.05- 0.11		

Note (i) BDL-Below Detection Limit (mg/L): Cr-0.00056, Cu- 0.00035, Fe- 0.00067, Ni -0.00054, Pb -0.00031 & Zn 0.00059

(ii) \uparrow and \checkmark indicate the increase or decrease in the parameters concentration.

3.1 Observations of Comparative Study

- In comparison to the previous year (2020) monitoring during Ganesh puja idol immersion, pH was observed slightly increased for pre and post idol immersion activity, whereas DO observed as decreasing in 2021 when compared with previous year during both pre and post-immersion activity. BOD observed as increased during 2021 during pre-immersion activity and decreased postimmersion.
- The concentration of Chromium, Iron and Zinc decreased than previous year for both pre and post immersion time, while concentration of Copper and Lead decreased during pre- immersion and remained same as that of the previous year post immersion.
- Above findings revealed that the DO value decreased while BOD increasing in post-immersion as compared to previous year (2020) which indicate discharge of untreated/ partially treated waste water into river Yamuna in Delhi. The concentration of Heavy metals such as Chromium, Iron and Zinc decreased in post immersion as compared to previous year (2020) which may be attributed to the ban of idol immersion in River Yamuna during Puja season and artificial ponds which were created for idol immersion activity all over the city of Delhi apart from dilution in River Yamuna due to monsoon season or release of water from Hathni kund Barrage.

Chapter 4

Water Quality of River Yamuna, Pre and Post-Idol Immersion during Durga Puja, 2021

Durga Puja festival was celebrated on **07.10.2021** and concluded (visarjan) on **14.10.2021**. The water quality monitoring was carried out in different ghats and river Yamuna locations during pre-idol immersion **(13.10.2021)** and post idol immersion **(16.10.2021)**. The photographs of sampling location during water quality monitoring are presented below: -

Pre-Idol Immersion



Figure 14: River Yamuna at Palla



Figure 16: River Yamuna at ITO Bridge



Figure 15: River Yamuna at Surghat



Figure 17: River Yamuna at Nizamuddin



Figure 18: River Yamuna at Okhla bridge at Kalindi Kunj



Figure 19: River Yamuna at Asgarpur, Okhla D/s

Figure 14- 19: The photographs of the sampling locations on River Yamuna during 13.10.2021 (pre-idol immersion)

Post-Idol Immersion



Figure 20: River Yamuna at Palla



Figure 21: River Yamuna at Surghat



Figure 22: River Yamuna at ITO Bridge



Figure 24: River Yamuna at Okhla bridge at Kalindi Kunj



Figure 23: River Yamuna at Nizamuddin



Figure 25: River Yamuna at Asgarpur, Okhla D/s

Figure 20- 25: The photographs of the sampling locations on River Yamuna during 13.10.2021 (post-idol immersion)

4.1 Analytical Results

Analysis results of samples collected during pre-immersion and post-Idol Immersion of Durga Puja, are tabulated in **Table 6 &7.**

Table 6: Analysis results (Physico-Chemical and Bacteriological Parameter) of Yamuna River water samples monitored at immersion ghats during pre and post-idol immersion activity during Durga Puja (13.10.2021 & 16.10.2021)

Sl. No.	Sampling Location Name	Sampling Date	Sampling Duration	pН	DO (mg/L)	BOD (mg/L)
	Water Quality Criteria fo	6.5-8.5	>5 mg/L	<3 mg/L		
1	Balla	13.10.2021	Pre	7.7	5.6	6
1		16.10.2021	Post	7.3 🗸	6.2	BDL
2	Surabat	13.10.2021	Pre	7.9	6.8	3
	Surghat	16.10.2021	Post	7.5 🦊	7.8 🕇	1.5
2	ITO Bridge	13.10.2021	Pre	9.5	0.9	12
5		16.10.2021	Post	7.2 🦊	1.1 🕇	8
4	Nizomuddin	13.10.2021	Pre	7.7	1.3	9
4	Nizamudum	16.10.2021	Post	7.3 🦊	1.2 🕇	10
5	Okhla bridge at Kalindi	13.10.2021	Pre	7.6	3.6	8
5	Kunj	16.10.2021	Post	7.4 🗸	3.8 🕇	9 🚺
6	Asgarpur Okhla D/s	13.10.2021	Pre	7.8	3.2	9
6	Asgarpur, Okilla D/S	16.10.2021	Post	7.2 🗸	1.2 🗸	8

Note (i) - pH, DO, BOD have been compared with Primary Water Quality Criteria for Outdoor Bathing notified under Environment (Protection) Rules, 1986 by Ministry of Environment, Forest & Climate Change (MoEF&CC).

- (ii) BDL for DO- 0.3 mg/L, BOD- 1 mg/L and FC- <1.8 MPN/100 ml.
- (*iii*) ↑ and ↓ indicate increase or decrease in parameters concentration.

Pre-immersion	Post-immersion
• Exceedance in pH value observed at	• No exceedance observed in pH value.
ITO Bridge.	• DO meeting the criteria at 02
• DO meeting the criteria at 02 locations	locations (at Palla and Surghat).
(at Palla and Surghat).	• BOD meeting the criteria at 02
• BOD meeting the criteria at one location	locations (at Palla and Surghat).
(Surghat) out of 6 monitored locations.	

Note (iv) - Graphical representation of DO & BOD during pre & post immersion during Durga Puja in Delhi given at Annexure III.

Table 7: Analysis results of Heavy metals of water samples of river Yamuna & immersion ghats monitored during pre and post -idol immersion activity during Durga Puja (13.10.2021 & 16.10.2021)

S1	Samaling	Comuling	Compling	Heavy Metals (mg/L)									
51. No.	Location Name	Date	Duration	As	Cd	Со	Cr	Cu	Fe	Mn	Ni	Pb	Zn
1101		Duit	2 41411011	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
1	Palla	13.10.2021	Pre	BDL	BDL	0.02	BDL	0.10	5.29	0.14	BDL	BDL	0.03
		16.10.2021	Post	BDL	BDL	0.01	BDL	BDL	4.05	0.08	BDL	BDL	0.02
2	Surghat	13.10.2021	Pre	BDL	BDL	BDL	BDL	0.07	1.60	0.06	BDL	BDL	0.02
		16.10.2021	Post	BDL	BDL	BDL	BDL	BDL	1.34	0.04	BDL	0.02	0.02
3	ITO Bridge	13.10.2021	Pre	BDL	BDL	BDL	0.01	0.10	1.34	0.15	BDL	BDL	0.04
		16.10.2021	Post	BDL	BDL	BDL	0.01	0.01	1.17	0.19	BDL	BDL	0.04
4	Nizamuddin	13.10.2021	Pre	BDL	0.06	BDL	BDL	0.07	0.75	0.14	BDL	0.13	0.57
		16.10.2021	Post	BDL	BDL	BDL	BDL	BDL	0.67	0.12	BDL	BDL	0.02
5	Okhla bridge at	13.10.2021	Pre	BDL	BDL	BDL	BDL	0.18	0.97	0.13	BDL	0.04	0.21
	Kalini Kunj	16.10.2021	Post	BDL	BDL	BDL	BDL	BDL	1.04 1	0.13	BDL	BDL	0.02
6	Asgarpur,	13.10.2021	Pre	BDL	BDL	BDL	BDL	0.09	0.78	0.11	BDL	0.01	0.06
	Okhla D/s	16.10.2021	Post	BDL	BDL	BDL	0.01	0.01	1.00 1	0.20	0.01	BDL	0.03

Note (i) - BDL-Below Detection Limit (mg/L): As-0.00049, Cd- 0.00042, Co- 0.00035, Cr-0.00056, Cu- 0.00035, Fe- 0.00067, Mn- 0.00043, Ni -0.00054, Pb -0.00031 & Zn 0.00059

(*ii*) - ↑ and ↓ indicate the increase or decrease in the parameters concentration.

Heavy Metals						
Pre-immersion	Post-immersion					
• Aresenic and Nickel observed 'BDL' at all the monitored locations.	• Aresenic and Cadmium observed 'BDL' at all the monitored locations.					
• Cadmium, Cobalt and Chromium observed 'BDL' at all the monitored locations except at one.	• Cobalt and Nickel observed 'BDL' at all the monitored locations except at one.					

4.2 Observations

Based on the water quality assessment at 06 monitored locations in Delhi carried out during pre and post idol immersion activity of Durga Puja, the observations are given below: -

4.2.1 Pre-idol immersion

The analysis results reveal the following: -

- pH is complying at all the monitored locations except at one (at ITO Bridge) and is observed in the range 7.6-9.5.
- Dissolved Oxygen (DO) was meeting with the criteria (>5 mg/L) at two monitored locations (Palla and Surghat).
- BOD was meeting with the criteria (<3mg/L) at one location (Surghat).
- Concentration of Arsenic (As) and Nickel (Ni) was observed as 'BDL' at all the monitored locations.
- Cadmium was observed in the range BDL- 0.06 mg/L, Cobalt in the range BDL- 0.02 mg/L, Chromium in the range BDL- 0.01 mg/L, Copper in the range 0.07- 0.18 mg/L, Iron in the range 0.75- 5.29 mg/L, Manganese in the range 0.06- 0.15 mg/L, Lead in the range BDL- 0.13 mg/L and Zinc was observed in the range 0.02- 0.57 mg/L.

4.2.2 Post-idol immersion

The analysis results reveal the following: -

- pH was within the limit of 7.2-7.5 at all the monitored locations.
- Dissolved Oxygen (DO) was meeting with the criteria (>5 mg/L) at two locations (at Palla and Surghat).
- BOD was meeting with the criteria (<3mg/L) at two locations (at Palla and Surghat).
- Concentration of Arsenic and Cadmium was observed as 'BDL' at all the monitored locations.
- Cobalt, Copper, Chromium and Nickel observed in the range BDL- 0.01 mg/L.
- Iron was observed in the range 0.67- 4.05 mg/L, Manganese in the range 0.04-0.20 mg/L, Lead in the range BDL- 0.02 mg/L and Zinc in the range 0.02- 0.04 mg/L.

4.2.3 Conclusion

- pH is complying at all the monitored locations except at ITO Bridge during preimmersion.
- During pre and post-idol immersion activity, DO was meeting the criteria at two locations i.e., at Palla and Surghat.
- Out of all six monitored locations, BOD was complying at two locations of Palla and Surghat post immersion and at Surghat during pre-immersion while increased in the lower stretch of the river which may be due to anthropogenic activity in terms of discharge of wastewater into River Yamuna.
- During post-idol immersion activity, increase in concentration was observed mainly in case of Iron and slightly for Manganese and decrease in concentration for Copper and Zinc was observed.

Note: Graphical representations for comparison of pre and post analysis of heavy metals is given at Annexure IV.

Annexure I



Figure 26: Graphical representation of Dissolved Oxygen during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.



Figure 27: Graphical representation of Biochemical Oxygen Demand during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.



Figure 28: Graphical representation of Fecal Coliform during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.





Figure 29: Graphical representation of Chromium during pre & Figure 30: Graphical representation of Copper during pre & post immersion during Ganesh Chaturthi in Delhi, 2021.

post immersion during Ganesh Chaturthi in Delhi, 2021.



Figure 31: Graphical representation of Nickel during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.



Figure 32: Graphical representation of Zinc during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.



Figure 33: Graphical representation of Iron during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.

Figure 34: Graphical representation of Manganese during pre & post immersion during *Ganesh Chaturthi* in Delhi, 2021.





Figure 35: Graphical representation of Dissolved Oxygen during pre & post immersion during *Durga Puja* in Delhi, 2021.



Figure 36: Graphical representation of Biochemical Oxygen Demand during pre & post immersion during *Durga Puja* in Delhi, 2021.

Annexure IV



Figure 37: Graphical representation of Zinc during pre & post immersion during *Durga Puja* in Delhi, 2021.

Figure 38: Graphical representation of Copper during pre & post immersion during *Durga Puja* in Delhi, 2021.



Figure 39: Graphical representation of Lead during pre & post immersion during Durga Puja in Delhi, 2021.

Figure 40: Graphical representation of Chromium during pre & post immersion during Durga Puja in Delhi, 2021.



Figure 41: Graphical representation of Iron during pre & post immersion during Durga Puja in Delhi, 2021.

Figure 42: Graphical representation of Manganese during pre & post immersion during Durga Puja in Delhi, 2021.

Annexure-V

Primary Water Quality Criteria for Bathing Waters.

In a water body or its part, water is subjected to several types of uses. Depending on the types of uses and activities, water quality criteria have been specified to determine its suitability for a particular purpose. Among the various types of uses there is one use that demands highest level of water quality or purity and that is termed as "Designated Best Use" in that stretch of water body. Based on this, water quality criteria. The primary water quality criteria for bathing water are specified along with the rationale presented below.

PRIMARY WATER QUALITY CRITERIA FOR BATHING WATER

S1. No.	Parameters	Criteria	Rationale			
1.	Fecal Coliform (MPN/100 ml)	500 (desirable) 2500 (Maximum Permissible)	To ensure low sewage contamination Fecal coliform and fecal streptococci are considered as they reflect the bacterial pathogenicity.			
2.	Fecal Streptococci (MPN/100 ml)	100 (desirable) 500 (Maximum Permissible)	The desirable and permissible limits are suggested to allow for fluctuation in environmental conditions such as seasonal change, changes in flow conditions etc.			
3.	pH:	Between 6.5 — 8.5	The range provides protection to the skin and delicate organs like eyes, nose, ears etc. which are directly exposed during outdoor bathing.			
4.	Dissolved Oxygen:	5 mg/1 or more	The minimum dissolved oxygen concentration of 5 mg/1 ensures reasonable freedom from oxygen consuming organic pollution immediately upstream which is necessary for preventing production of anaerobic gases (obnoxious gases) from sediment.			
5.	Biochemical Oxygen Demand (3 day,27°C)	3 mg/l or less	The Biochemical Oxygen Demand of 3mg/1 or less of the water ensures reasonable freedom from oxygen demanding pollutants and prevent production of obnoxious gases.			

(Water used for organized outdoor bathing)