

Pollution Assessment of River Kali-East: A Tributary of River Ganga



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ACKNOWLEDGEMENTS

This report “Pollution Assessment of River Kali-East: A Tributary of River Ganga” is the outcome of the study on the environmental issues in the catchment area of river Kali-East carried out by Central Pollution Control Board (CPCB) during 2019. This report provides a detailed record of the water quality of river Kali-East with special emphasis on pollution load contributed by drains discharging wastewater into the river Kali-East and evaluation of performance of sewage and common effluent treatment plants in the catchment area.

This report has been conceptualised and prepared under the guidance of Dr. Prashant Gargava, Member Secretary, CPCB and Dr. Ajit Kumar Vidyarthi, Director, CPCB. The contribution of Ms. Garima Dublish, Research Associate-III and Dr. Vivek Rana, Research Associate-I in analysing data and preparation of report is also acknowledged.

This work was supported by National Mission for Clean Ganga (NMCG) under Pollution Inventorization, Assessment and Surveillance on River Ganga (PIAS) project and World Bank Funded Strengthening of Environmental Regulators (SER) project. CPCB thankfully acknowledge the support extended by the Uttar Pradesh Pollution Control Board during monitoring and sample collection. The valuable suggestions of Prof. C. B. Majumder, Department of Chemical Engineering, IIT Roorkee to improve the quality of the report are also appreciated.

1. INTRODUCTION

Kali-East is a non-perennial river, which originates from a pond at Chitora in Muzaffarnagar district (Uttar Pradesh) as a narrow stream and traverses a distance of 550 km before meeting river Ganga in Kannauj (U.P.). During its passage, it flows through the districts of Muzaffarnagar, Meerut, Hapur, Ghaziabad, Bulandshahar, Aligarh, Kasganj and finally merges with River Ganga at Kannauj in Uttar Pradesh on right bank.

Earlier during non-monsoon season, the river flows through groundwater recharge. Presently the river Kali-East carries mostly industrial and domestic wastewater discharged from near-by towns of Muzaffarnagar, Meerut, Hapur, Ghaziabad, Bulandshahar, Aligarh, Kasganj and Kannauj. In total, 26 identified drains meet river Kali-East along its entire stretch. Some of these drains carry domestic wastewater while other carry mixed (domestic and industrial) wastewater thereby increasing the pollution load in the river. There are a total of 97 grossly polluting industries (GPIs) in the catchment of the river Kali-East which encompasses various sectors such as sugar, distillery, chemical, pulp & paper, textiles and slaughter house. These industries may pose a threat to the river ecosystem if an illegal discharge of untreated effluent is there. The river experiences extreme pollution load in its stretch from Muzaffarnagar to Bulandshahar. However, Ganga canals carrying freshwater meet the river at two locations: (i) near Khurja, downstream of Bulandshahar and (ii) near Nadrai bridge, upstream of Kasganj town which improves the water quality of the river due to dilution.

2. OBJECTIVE OF THE STUDY

The degree of pollution in the river Kali-East is referred as “deadly alarming” by the Hon’ble National Green Tribunal (Government of India) which may be attributed to the discharge of industrial effluents into the river system. Since Kali-East is one of the major tributaries of River Ganga, its pollution level affects the water quality of the river Ganga. The objectives of the present study were: (i) To assess water quality of river Kali-East from its origin to confluence with the river Ganga; (ii) To assess pollution load contributed by drains discharging wastewater into the river Kali-East; and (iii) To evaluate performance of sewage and effluent treatment plants in the catchment of the river Kali-East.

The area under the present study is a part of the Indo-Gangetic Plain, lying between latitude 29°9'34.29" N to 27°1'32.34" N and the longitude 77°45'15.10" E to 77°58'14.03" E in Uttar Pradesh. The climate of the area is humid sub-tropical. Location of Drains, STPs, GPIs and Canals in the catchment area of the river Kali-East is shown in **Figure 1**.

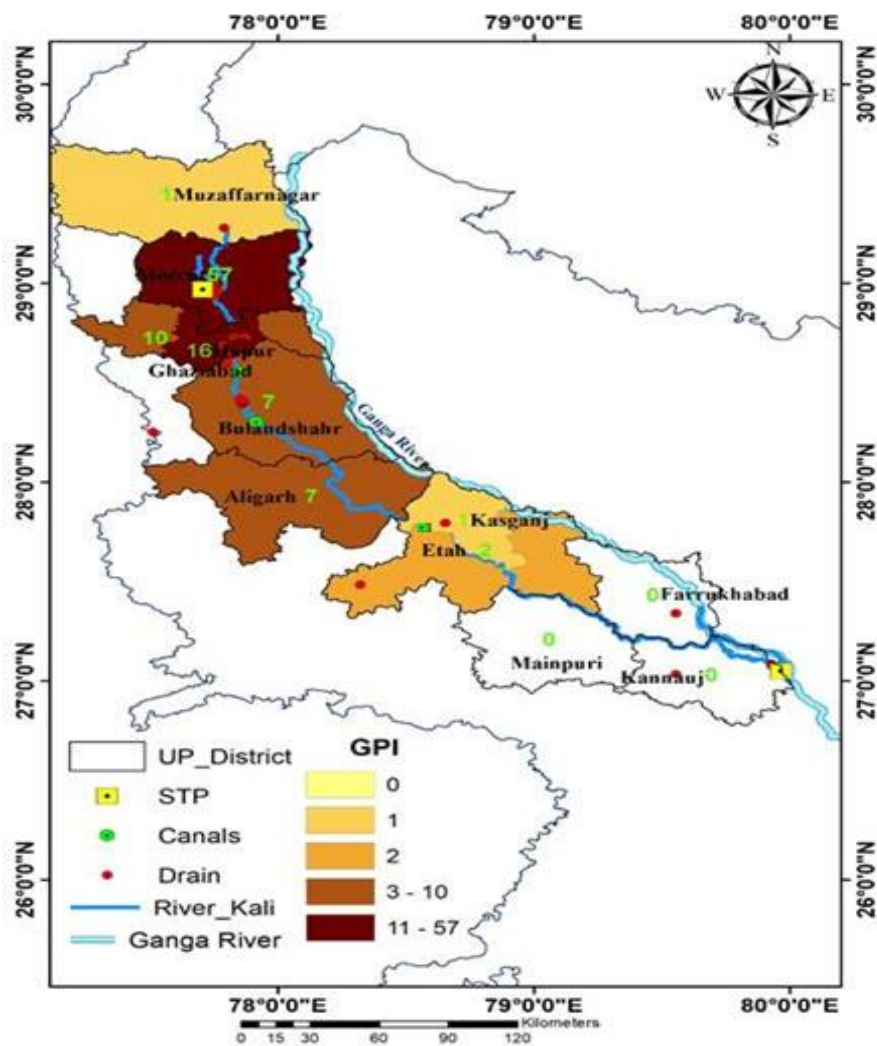


Figure 1 Location of Drains, STPs, GPIs and Canals in the catchment area of the river Kali-East

3. METHODOLOGY

To assess the impact of pollution load contributed by drains and industrial clusters, the water quality of the river has been monitored at downstream of major industrial clusters, urban centres and downstream of confluence of drains in the entire stretch (27 locations on river Kali-East and 01 location on river Ganga) from Khatauli (Muzaffarnagar, U.P.) to Kannauj (U.P.) during pre-monsoon season 2019 (March-May) (**Table 1 & Figure 2**) and to assess the pollution load contributed by drains, the monitoring of 26 adjoining drains was also carried out along with the river monitoring (**Table 2**). Also, inspection of sewage treatment plants (12 in Meerut and 01 in Kannauj) and common effluent treatment plants (01 in Pilakhua) in the catchment area of the river was carried out (**Table 3**). The monitoring was carried out jointly by CPCB and UPPCB. The collected samples were transported to the laboratory and analyzed

for physical, chemical and biological properties as per standard methods [American Public Health Association (APHA) and approved protocols under the National Accreditation Board for Laboratories (NABL)].

Table 1 Water quality monitoring locations on the river Kali-East

S. No.	Sampling Locations	Geographical Coordinates	
		Latitude (N)	Longitude (E)
Muzaffarnagar			
1.	U/s of Sugar Mill Drain	29.279192	77.788599
2.	D/s of Sugar Mill Drain	29.278181	77.787853
3.	D/s of Muzaffarnagar-Khatauli near Khadli Village	29.197999	77.799431
Meerut			
4.	U/s of Vill. Saini	29.056165	77.767262
5.	D/s of Vill. Saini	29.028941	77.792795
6.	U/s of Abu Nala-1	28.969660	77.774254
7.	D/s of Abu Nala-1	28.960122	77.765603
8.	D/s of Abu Nala -2	28.931889	77.756765
9.	D/s of Odean Nala	28.921457	77.756156
Hapur			
10.	U/s of Hapur City Drain	28.726175	77.831318
11.	U/s of Chhoiya Drain	28.695226	77.848477
12.	D/s of Chhoiya drain	28.694523	77.850791
Ghaziabad			
13.	D/s of Hapur Drain	28.63685	77.814130
14.	D/s of Kadrabad Drain	28.625799	77.816904
15.	D/s of Gulaothi drain	28.591529	77.824883
Bulandshahar			
16.	U/s of Bulandshahar Drains	28.420485	77.851609
17.	U/s of Devipura Drain	28.413062	77.858749
18.	D/s of Devipura Drain	28.412494	77.858969
19.	D/s of Bulandshahar Drains	28.392070	77.864000
Aligarh			
20.	U/s of Wave Distilleries and Breweries, Aligarh	27.980513	78.199289
21.	D/s of Wave Distilleries and Breweries, Aligarh	27.974796	78.207298
Kasganj			
22.	D/s of Neem Nala	27.807538	78.543141
23.	U/s of Kasganj Drain	27.787246	78.627322
24.	D/s of Kasganj Drain	27.787246	78.627322
Kannauj			
25.	At Khudaganj Bridge	27.177500	79.676667
26.	U/s of Patta Nala	27.081433	79.927073
27.	D/s of Patta Nala	27.080855	79.931004

Table 2 List of drains discharging wastewater into the river Kali-East

S. No.	Drains	Source of pollution	Geographical Coordinates	
			Latitude (N)	Longitude (E)
1.	Sugar Mill Nala	Mixed	77.771723	29.277512
2.	Village Saini Drain	Mixed	77.785281	29.045227
3.	Abu Nala-1	Mixed	77.760229	28.974999
4.	Abu Nala-2	Mixed	77.753759	28.938786
5.	Odean Nala	Mixed	77.749792	28.932410
6.	Hapur City Drain	Mixed	77.829546	28.726201
7.	Chhoiya Drain	Mixed	77.862721	28.712963
8.	Hapur Drain	Mixed	77.804845	28.642790
9.	Kadradbad Drain	Mixed	77.804746	28.635293
10.	Gulaothi Drain	Mixed	77.803061	28.591294
11.	DM colony Drain	Domestic	77.85176	28.419883
12.	Behind chamunda mandir Drain	Domestic	77.853463	28.417103
13.	Devipura Drain	Domestic	77.858481	28.412642
14.	Behind shanidev mandir Drain	Domestic	77.860892	28.409911
15.	Faisalabad Drain	Mixed	77.864000	28.409000
16.	Kasaiwada Drain	Domestic	77.862330	28.407526
17.	Nahsal ghat Drain	Domestic	77.866333	28.404597
18.	Cheel ghat Drain	Domestic	77.866675	28.400653
19.	Chandbhari road Drain	Domestic	77.865031	28.399883
20.	Aadil Nala	Domestic	77.862753	28.396225
21.	Maman road Drain	Mixed	77.863288	28.392665
22.	Neem Nala	Domestic	78.543141	27.807538
23.	Kasganj Drain	Domestic	78.652609	27.796154
24.	Patta Nala	Mixed	79.927500	27.080555
25.	Adanga Nala	Domestic	79.944722	27.063600
26.	Tammi Nala	Domestic	79.929400	27.051100

Table 3 Detail of STPs and CETPs in the catchment of the river Kali-East

District	Name of STP/CETP	Designed Capacity (in MLD)	Geographical Coordinates	
			Latitude (N)	Longitude (E)
Sewage Treatment Plants				
Meerut	Pallavpuram Phase-I STP	07	29.056523	77.717790
	Pallavpuram Phase-II STP	11	29.057869	77.718699
	Shraddhapuri Phase-I STP	6	29.034058	77.675628
	Shraddhapuri Phase-II STP	6	29.026207	77.665765
	Ganga Nagar STP	10	28.997914	77.749775
	Pandav Nagar STP	3	28.989114	77.733416
	Rakshapuram STP	6	29.010823	77.738198
	Shatabdi Nagar STP	15	28.921146	77.661348
	Sports Good Complex STP	7	28.946296	77.678430
	U.P. Jal Nigam STP	72	28.939721	77.756580
	Vedvyas Puri STP	15	28.937734	77.653738
	Lohia Nagar STP	10	28.939267	77.740442
Kannauj	Kannauj STP	13	27.075444	79.926583
Total		181 MLD		
Common Effluent Treatment Plant				
Pilakhua	Pilakhua CETP	2.1	28.700587	77.672126

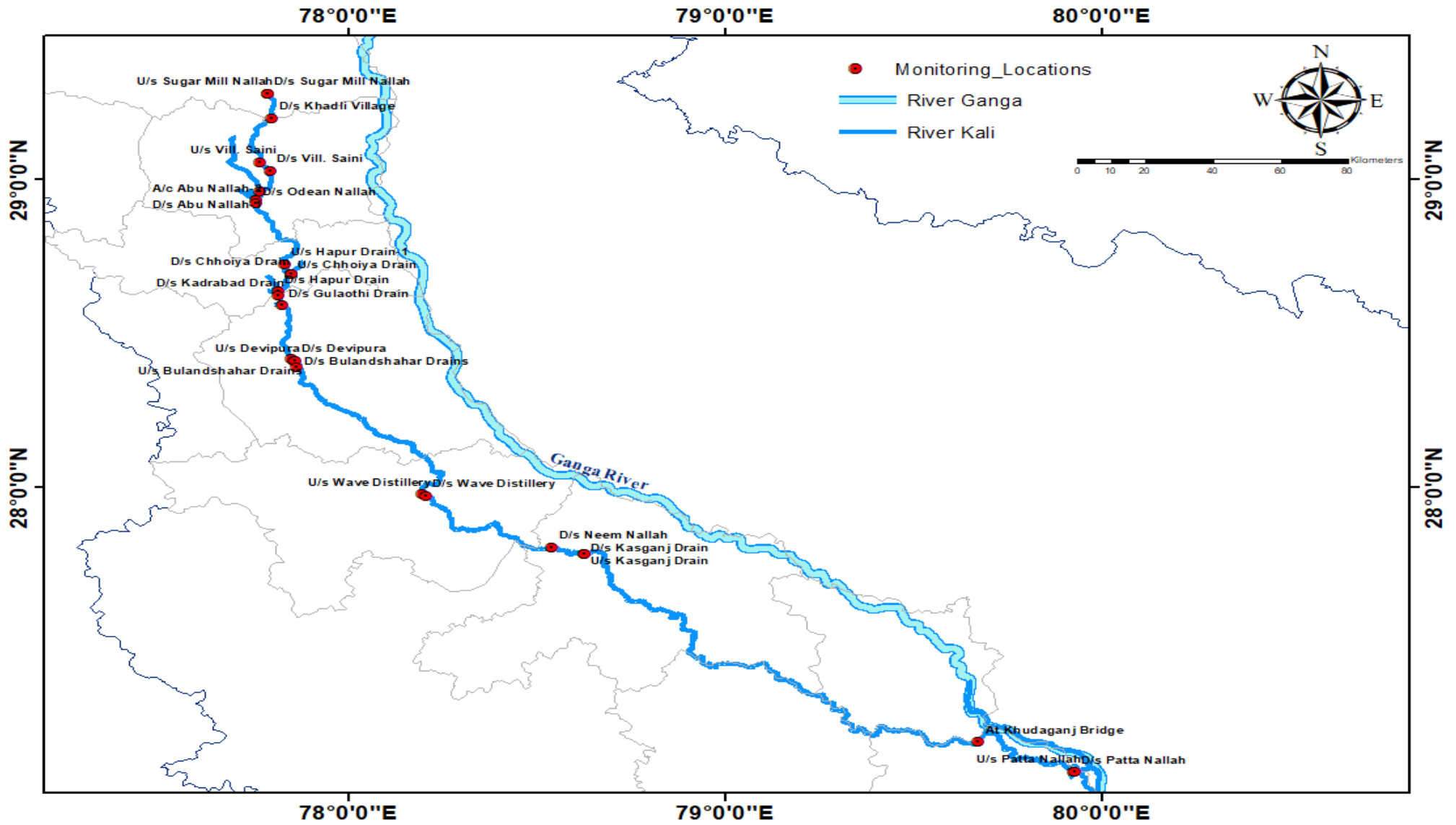


Figure 2 Map of water quality monitoring locations on the river Kali-East

4. OBSERVATIONS

4.1 Water Quality of river Kali-East

Monitoring was carried out jointly by the teams of CPCB and UPPCB from Khatauli (Muzaffarnagar) to the confluence point of the river Kali-East with the river Ganga in Kannauj. The samples collected were tested for physico-chemical parameters, biological parameters, and heavy/trace metals. The detailed results of all the parameters at each sampling location are summarized in **Annexure-I**.

At Khatauli – Miranpur road near Khatauli (Muzaffarnagar) before confluence of sugar mill drain, it was observed that the river was dry. On tracking river approximately up to 1 km upstream to the sampling point (up to Vill. Paldi), it was found that the river was completely dry (**Figure 3**). The Sugar mill drain (Flow-20.5 MLD, BOD-1067 mg/l and pollution load-21.9 TPD) meets river Kali-East at the right bank. The River Kali East has low flow at D/s of Sugar Mill drain because backflow was observed in river at this location. At this location, the BOD of river Kali-East was observed as 410 mg/l, DO was NIL, COD was 1070 mg/l, TDS was 1094 mg/l and pH was 4.9. Acidic pH and high BOD indicate discharge from nearby industrial units. The inspection team observed dense vegetation and dumped solid waste on the riverbed. Meagre flow was observed in River Kali-East near Khadli Village which is approximately 8 km D/s of confluence point of Sugar mill drain (**Figure 4 & 5**).

At U/s of village Saini the river was found again dry (**Figure 6**). Moderate flow was observed in the river at D/s village Saini due to the discharge of industrial effluent from the cluster of pulp and paper units located in the vicinity (**Figure 7**). Some of these industries discharge directly into the river and some through Saini Village drain. The DO, BOD, COD and TDS at D/s of village Saini was Nil, 132 mg/l, 421 mg/l and 2536 mg/l, respectively. The pH at this location was 6.7.



Figure 3 River Kali-East before confluence (~ 1 km) with Sugar Mill Drain

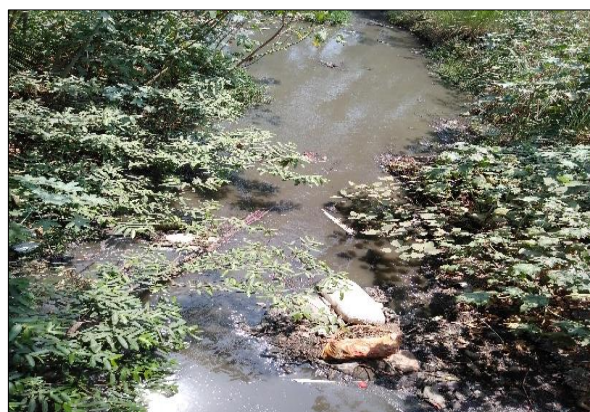


Figure 4 River Kali-East D/s of Sugar Mill Drain



Figure 5 River Kali-East D/s of Muzaffarnagar near Khadli Village



Figure 6 River Kali-East dry at U/s of village Saini



Figure 7 River Kali-East D/s village Saini

Three major drains namely Abu Nala-1 (Khinauni Drain), Abu Nala-2 and Odean Nala (Slaughter House drain) discharge wastewater of Meerut city into River Kali-East. All three drains join the river Kali-East from the right bank and carry domestic as well as industrial wastewater. The team observed that the river was flowing with heavy silt-load and vegetation. Abu Nala-1 (Flow - 82.4 MLD, BOD - 93 mg/l and pollution load - 7.67 TPD) and Abu Nala-2 (Flow - 199 MLD, BOD - 89 mg/l and pollution load - 17.72 TPD) discharges significant wastewater into river Kali-East. These drains carry sewage of Meerut city and industrial wastewater of Sugar, chemical, textile and distillery units situated in the vicinity. Moreover, solid waste and other biological materials are also dumped along drains and directly into the river. The flow in the river D/s of Abu-Nala-1 was 77.76 MLD, BOD, colour and DO were 146 mg/l, BDL and NIL, respectively. Heavy vegetation and solid waste was also observed in the river-bed. Agricultural land was being irrigated from river wastewater (**Figure 8**). The TDS in

the river Kali-East at U/s and D/s of Abu Nala-1 was 2376 mg/l and 1176 mg/l, respectively. The Abu Nala-2 is partially tapped at 72 MLD STP situated U/s to the confluence point of Abu-Nala-2 with the river.



Figure 8 Irrigation of adjacent agricultural land by water of river Kali-East

After confluence with Abu Nala-2, Odean Nala or Slaughter House drain (Flow - 200 MLD, BOD - 311 mg/l and pollution load - 62.2 TPD) discharges wastewater into the river. De-silting or dredging work of River Kali-East was seen at the bridge near Jallalpur village (D/s of Odean Nala) at the time of sampling (**Figure 9-10**). Illegal slaughtering was observed in the vicinity of Odean Nala. At D/s of Odean Nala, flow of the river was 273.71 MLD, BOD and DO was 154 mg/l and NIL, respectively. Solid waste and vegetation were prevalent on the river bed.



Figure 9 River Kali-East A/c of Odean Nala



Figure 10 Confluence point of Odean Nala with river Kali-East

In Hapur district, four major drains discharge wastewater into river Kali-East namely Hapur City drain, Chhoiya drain, Hapur drain and Kadrabad drain. The wastewater of Hapur city is

discharged through Hapur city drain into river Kali-East. The flow in the river U/s of Hapur city drain was 133.33 MLD, DO was nil, BOD was 86 mg/l and COD was 1074 mg/l. The water colour at this location was greyish-black. This is a domestic drain (Flow - 1.1 MLD, BOD - 75 mg/l and pollution load - 0.09 TPD). The flow in the river at D/s of Hapur City Drain was 149.48 MLD. The dissolved oxygen was found NIL at this location, BOD was 80 mg/l and COD was 778 mg/l. Municipal solid waste was found littered around the river (**Figure 11**). Heavy silt deposition in the river-bed was also observed.

In Hapur district, another drain viz Chhoiya drain (Flow - 21.8 MLD, BOD - 27 mg/l and pollution load - 0.59 TPD), meets the river and carries domestic and industrial wastewater of Meerut District. At the confluence point of this drain a channel from Madhya Ganga canal also joins the river Kali-East. On the day of inspection, no release of fresh water from canal was observed. The industries in the vicinity of the drain are mainly pulp and paper, sugar and distillery. The team observed reddish black coloured river-bed and pronounced foul smell around the river at this location which indicates increased microbial activity in the river. The water from the river was being pumped out to irrigate the adjoining agricultural lands. The flow in river at D/s of Chhoiya drain was found to be 152.47 MLD, BOD, Colour and DO were 86 mg/l, 178 Hazen and NIL, respectively. The foul smell in the river at this location indicates anaerobic microbial activities in the river (**Figure 12**).



Figure 11 River Kali-East U/s Hapur city Drain



Figure 12 Confluence point of Chhoiya Drain with River Kali-East

Hapur drain is a mixed drain and carries wastewater of Meerut and Hapur districts. Water quality of River Kali-East was evaluated at D/s of Hapur Drain, the flow in the river at this location was 123.86 MLD. The dissolved oxygen was found NIL and BOD was 92 mg/l and COD was 469 mg/l. The water from the river was being pumped out to irrigate the adjoining agricultural land (**Figure 13**).

After Hapur drain, the Kadrabad drain discharges wastewater of some parts of Meerut, Hapur and Ghaziabad districts into river. The Kadrabad drain carries domestic sewage as well as industrial effluent of pulp and paper, sugar, distillery and textile units and CETP (2.1 MLD) located at Pilakhua (**Figure 14**). The flow of River Kali East D/s of Kadrabad Drain was 145.152 MLD, BOD and colour was 73 mg/l and 173 Hazen, respectively.



Figure 13 Confluence point of River Kali-East and Hapur drain



Figure 14 River Kali-East D/s of Kadrabad drain near Banboi and Akbarpur village

In Gulaothi town of Bulandshahar district, Gulaothi drain (Flow - 54 MLD, BOD - 150 mg/l and pollution load - 8.1 TPD) carrying sewage of the residential area and treated effluent from industrial units meets the river at the right bank. The BOD in the river at D/s Gulaothi drain was 78 mg/l, colour and DO was BDL and NIL, respectively.

In Bulandshahar city, there are 11 drains which discharge into River Kali East. All these drains are very closely located. The drains meeting at the right bank of the river are DM colony drain, behind Chamunda mandir drain, Devipura drain, Behind Shanidev mandir drain, Faisalabad drain, Kasaiwada drain, Nahsal ghat drain, Chandbhari road Nala, Aadil Nala and Maman road Nala. The drain meeting at the left bank of the river is Cheel ghat drain. The river sample was taken from upstream of Bulandshahar city. The DO was found NIL in Kali East River at upstream of Bulandshahar and BOD was 33 mg/l.

Water quality of River Kali-East U/s Devipura drain, Bulandshahar indicated DO- NIL, BOD- 45 mg/l and COD-219 mg/l. Near confluence point of Devipura drain solid waste dumping along drain and river bed was observed (**Figure 15 & 16**). At D/s of Devipura drain, DO, BOD and COD was NIL, 52 mg/l and 135 mg/l, respectively. At D/s Bulandshahar drains i.e. after

the confluence of all the drains of the city, the BOD and COD levels increased to 186 mg/l and 1409 mg/l, respectively (**Figure 17**).



Figure 15 River Kali-East U/s Devipura drain, Bulandshahar



Figure 16 River Kali-East D/s Devipura drain



Figure 17 River Kali-East D/s Bulandshahar city

In Aligarh, river water quality was monitored at upstream and downstream locations of Wave distillery. The water appeared to be brownish-black in color (**Figure 18 & 19**). Sufficient flow was observed in the river. A significant reduction in BOD values as compared to D/s of Bulandshahar was observed at this location and DO was also observed at this location. BOD and DO at U/s of Wave Distillery were observed as 22 mg/l and 0.85 mg/l, respectively. However, at D/s of Wave Distillery, no marked difference in water quality was observed, BOD and DO levels being 23 mg/l and 0.56 mg/l, respectively.



Figure 18 River Kali-East U/s Wave Distillery



Figure 19 River Kali-East D/s Wave Distillery

In Kasganj, two drains namely Neem Nala and Kasganj drain meet river Kali-East at the left bank. Neem Nala was found dry. The water quality of River Kali-East at D/s of Neem Nala was evaluated and the BOD and DO were found to be 28 mg/l and 5.71 mg/l, respectively which indicates that in absence of pollution source the river revives itself with the space and time. Drain in the Kasganj area (Kasganj drain) carries domestic wastewater. The wastewater of this drain is also used in agricultural activities. The river water sample was also collected from upstream and downstream of the confluence of Kasganj drain (Flow - 4.84 MLD, BOD - 78 mg/l and pollution load - 0.38 TPD).

The DO was NIL in the stretch from Muzaffarnagar to Bulandshahar. It was observed that there was an addition of fresh water from the upper Ganga Canal near Khurja, downstream of Bulandshahar and from the lower Ganga canal near Nadrai Bridge, upstream of Kasganj town. Due to this, rise in DO and depletion in BOD in the river was observed in Aligarh and Kasganj. The DO increased from 5.9 to 8.16 mg/l and BOD reduced from 27 to 6.9 mg/l at downstream of the confluence point of Kasganj drain with river Kali-East as compared to that at upstream of the confluence. This is due to the discharge of freshwater from lower Ganga canal into river Kali-East near Kasganj (**Figure 20**).

The river water sample was collected from Khudaganj in Kannauj. Khudaganj Bridge at river Kali-East represents the upstream of Kannauj city. The water level was very low due to the summer season (**Figure 21**).



Figure 20 River Kali-East after release of fresh water from canal at Kasganj



Figure 21 River Kali-East at Khudaganj village

In the Kannauj district, three drains namely Adanga Nala, Patta Nala, and Tammi Nala are meeting the river at the right bank. A STP of 13 MLD capacity is installed to tap these drains. It was observed that at the time of sampling the wastewater in Adanga Nala (Flow - 3.97 MLD, BOD - 50.4 mg/l and pollution load - 0.2 TPD) was not being pumped to Sewage Pumping Station. However, before meeting river Kali-East, wastewater was used by farmers for irrigation and it was found dry at confluence with river Ganga (**Figure 22**). Tammi Nala (Flow -1.2 MLD, BOD - 53.2 mg/l and pollution load - 0.07 TPD) was monitored after tapping arrangement and this drain carries domestic wastewater from nearby areas. Taping was not proper and a huge amount of solid waste was found dumped in the drain (**Figure 23-24**).



Figure 22 Solid waste dumping in Adanga Nala

The river water sample was also collected from the upstream and downstream locations of Patta Nala (Kannauj). At the upstream location of Patta Nala, the river was having a very lean flow with a DO value of 7.6 mg/L. The treated water from STP is discharged into Patta Nala which

finally discharged into River Kali-East along with untreated wastewater, thus reducing the DO to 2.5 mg/L and BOD increased to 15.6 mg/l (**Figure 25**).



Figure 23 Tammi Nala in Kannauj



Figure 24 Domestic solid waste near tapping Point of Tammi Nala, Kannauj

River Kali-East merges with River Ganga near Manimau Bridge. The sample was collected at a location near Durjanpur village from river Ganga after the confluence with the river Kali-East (**Figure 26**). After confluence of Kali-East the BOD in river Ganga was 6.6 mg/l.



Figure 25 STP outlet discharging wastewater into the Patta Nala



Figure 26 River Ganga a/c with the river Kali-East

The DO-BOD variation in entire stretch of river Kali-East along with contribution of pollution load is shown in **Figure 27**.

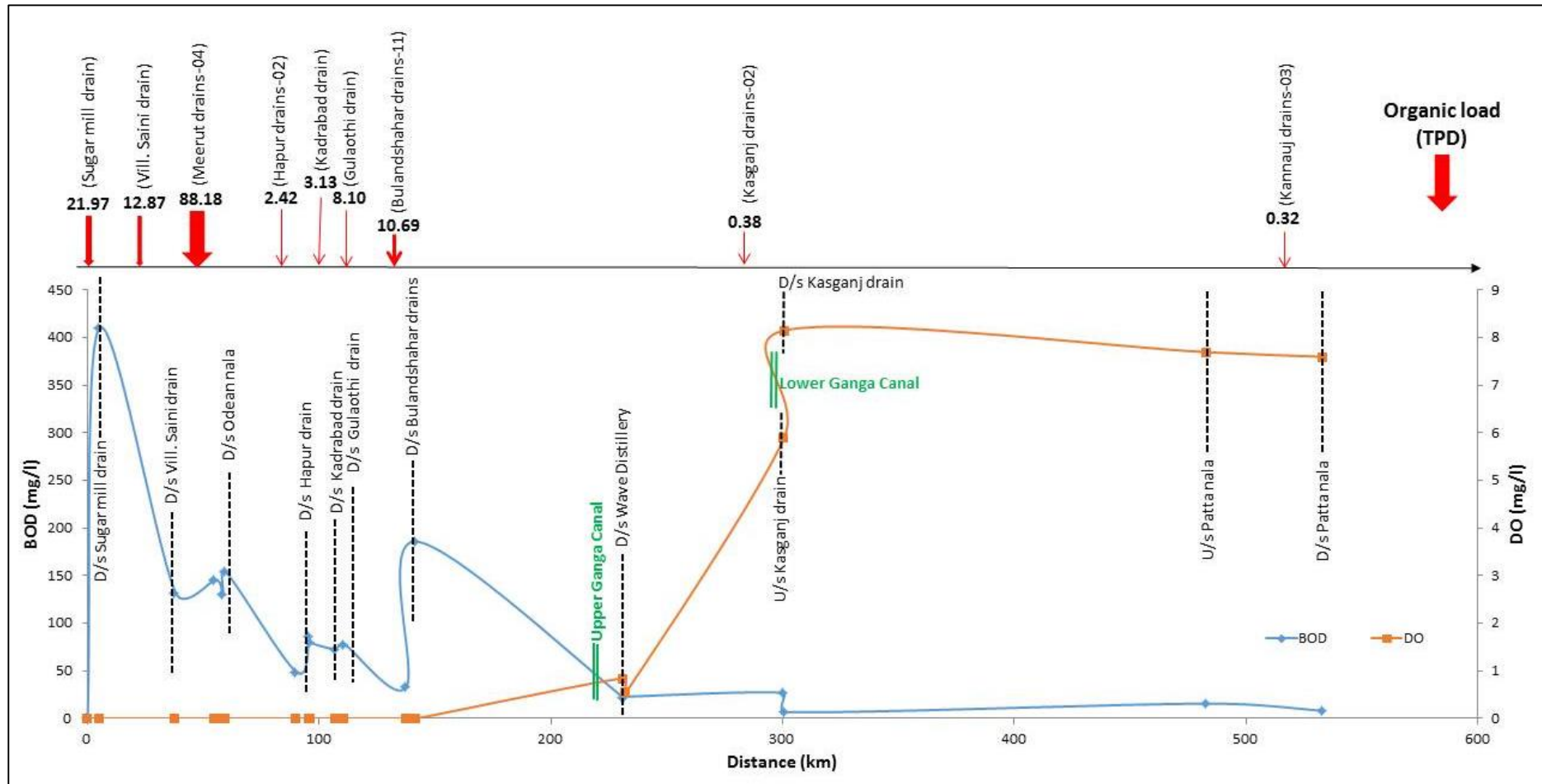


Figure 27 Longitudinal profile of DO-BOD variation in river Kali-East and organic pollution load (in terms of BOD) contribution

In river Kali-East, high color (143-200 Hazen) was observed from U/s of Hapur city drain to D/s of Kadrabad drain. High NH₃-N concentration (26.7-77.4 mg/l) was found in the stretch from Meerut (D/s of Abu Nala-1) to Kasganj (D/s of Neem Nala) which indicated discharge of domestic wastewater in the river. Solid waste dumping was found along river Kali-East and drains in the stretch from Meerut to Bulandshahar which could be another reason for high NH₃-N concentration in river water. Nitrate concentration ranged as 0.1-5.8 mg/l in river Kali-East and 0.7-4.6 mg/l in drains. After discharge of fresh water from Ganga canal, the NH₃-N concentration reduced and varied between 1.5 to 6.2 mg/l in the stretch from U/s of Kasganj drain to D/s of Patta Nala. The FC level was not meeting the primary water quality criteria for bathing waters in the whole stretch of the river except two locations namely, U/s of Kasganj drain (490 MPN/100 ml) and at Khudaganj bridge (2000 MPN/100 ml) due to discharge of fresh water from Ganga canal at U/s Kasganj drain. The concentration of metals Cr, Cu, Fe, Pb, Mn, Ni, Zn, Co, and V was found highest at D/s of Bulandshahar drains. The metals surpassed the prescribed limits for drinking water given by the Bureau of Indian Standards (IS 10500: 2012) - (i) Cadmium in river stretch from D/s of Abu Nala-2 to D/s of Bulandshahar drains except two locations at U/s of Bulandshahar drains and D/s of Devipura drains. Also, river at D/s of Patta Nala in Kannauj was not meeting the drinking water standards; (ii) Chromium at D/s of Abu Nala-2, D/s of Chhoiya drain, and D/s of Bulandshahar drains; (iii) Iron from D/s of Sugar Mill drain in Muzaffarnagar to D/s of Kasganj drain; (iv) Lead from D/s of Sugar Mill drain in Muzaffarnagar to D/s of Bulandshahar drains; (v) Manganese at D/s of Abu Nala-2, D/s of Bulandshahar drains, D/s of Wave Distilleries and Breweries, Aligarh, and D/s of Neem Nala; (vi) Nickel at D/s of Abu Nala-2, D/s of Odean Nala, U/s of Hapur city drain, U/s and D/s of Chhoiya drain, D/s of Hapur drain, U/s of Devipura drain, D/s of Bulandshahar drains, at Khudaganj bridge, U/s and D/s of Patta Nala and river Ganga A/c with river Kali-East; and (vii) Mercury at D/s of Devipura Drains in Bulandshahar.

4.2 Assessment of Pollution in Drains during Pre-monsoon 2019

There are 26 major drains that directly discharge their effluents into the river. During pre-monsoon 2019, the total flow and pollution load discharged from drains was 799.6 MLD and 148.1 TPD, respectively, out of which 782 MLD (97%) wastewater and 147.4 TPD (99.5%) BOD load is discharged in the stretch of Khatauli-Bulandshahar. Odean Nala/Slaughter house drain of Meerut is the major contributor in terms of pollution load followed by Sugar mill drain, Khatauli (42% and 15% respectively of total BOD load contributed by drains). Two drains

namely the Odean Nala/Slaughter house drain and Abu Nala-2 of Meerut account for 54% of the total wastewater being discharged into the river through drains (Figure 28 & 29).

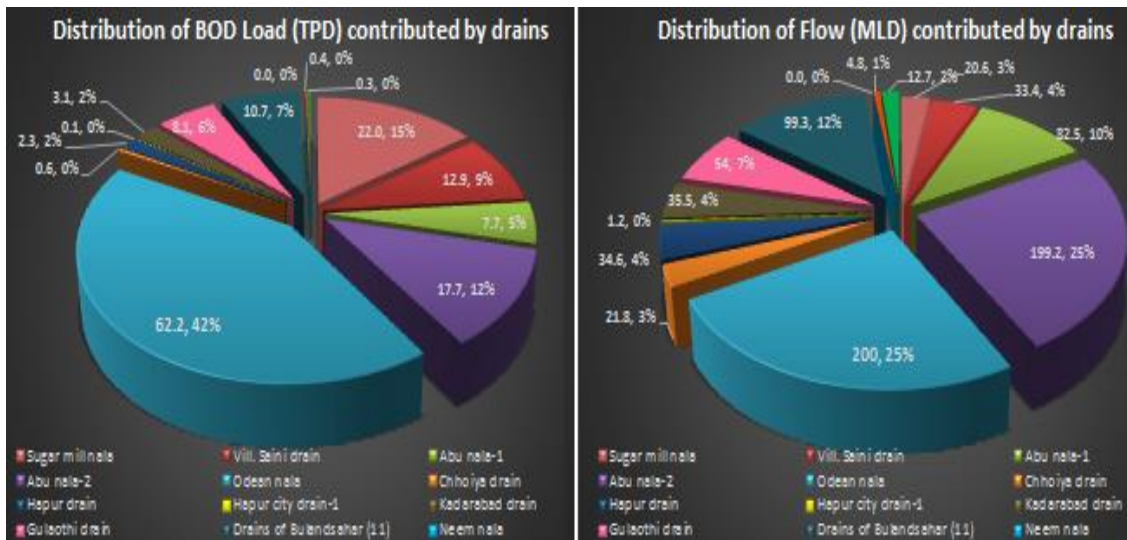


Figure 28 Contribution of flow and pollution load to river Kali-East through drains in 2019 (pre-monsoon)

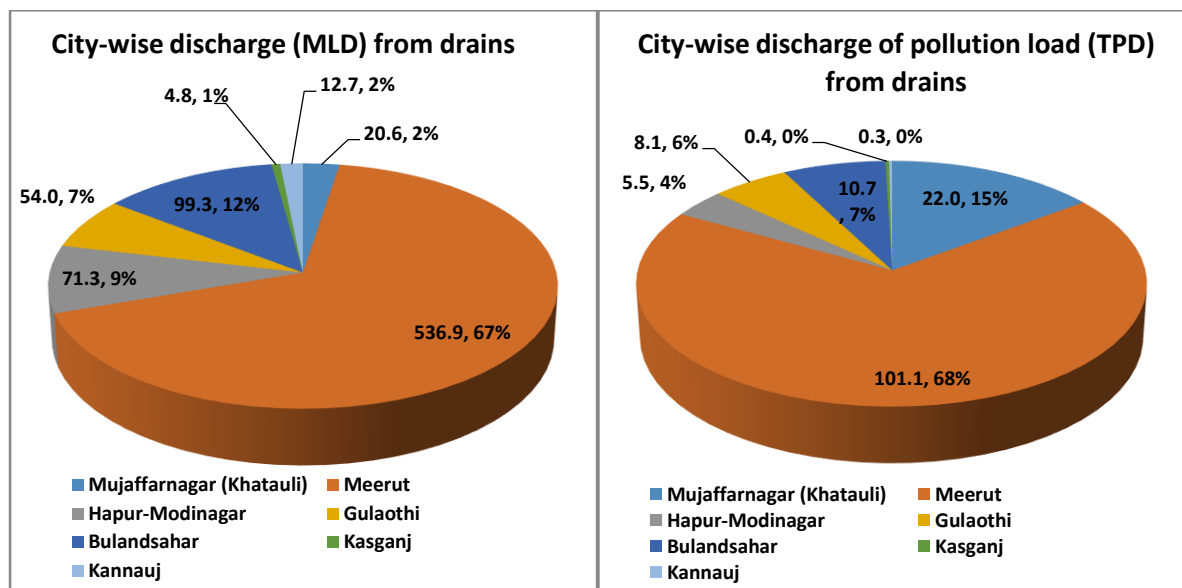


Figure 29 Contribution of flow (MLD) and pollution load (TPD) in 2019 (pre-monsoon) through drains (City-wise)

Meerut city through five drains namely Saini Village drain, Abu Nala-1, Abu Nala-2, Odean Nala and Chhoiya drain contributes 67% flow (536.9 MLD) and 68% BOD load (101.1 TPD) of the total flow and BOD load discharged through drains in River Kali-East. However, the Kadrabad drain and Hapur drain also carry wastewater of Meerut district. The schematic presentation of district-wise wastewater discharged by drains in to river Kali-East estimated during pre-monsoon-2019 is shown in Figure 30.

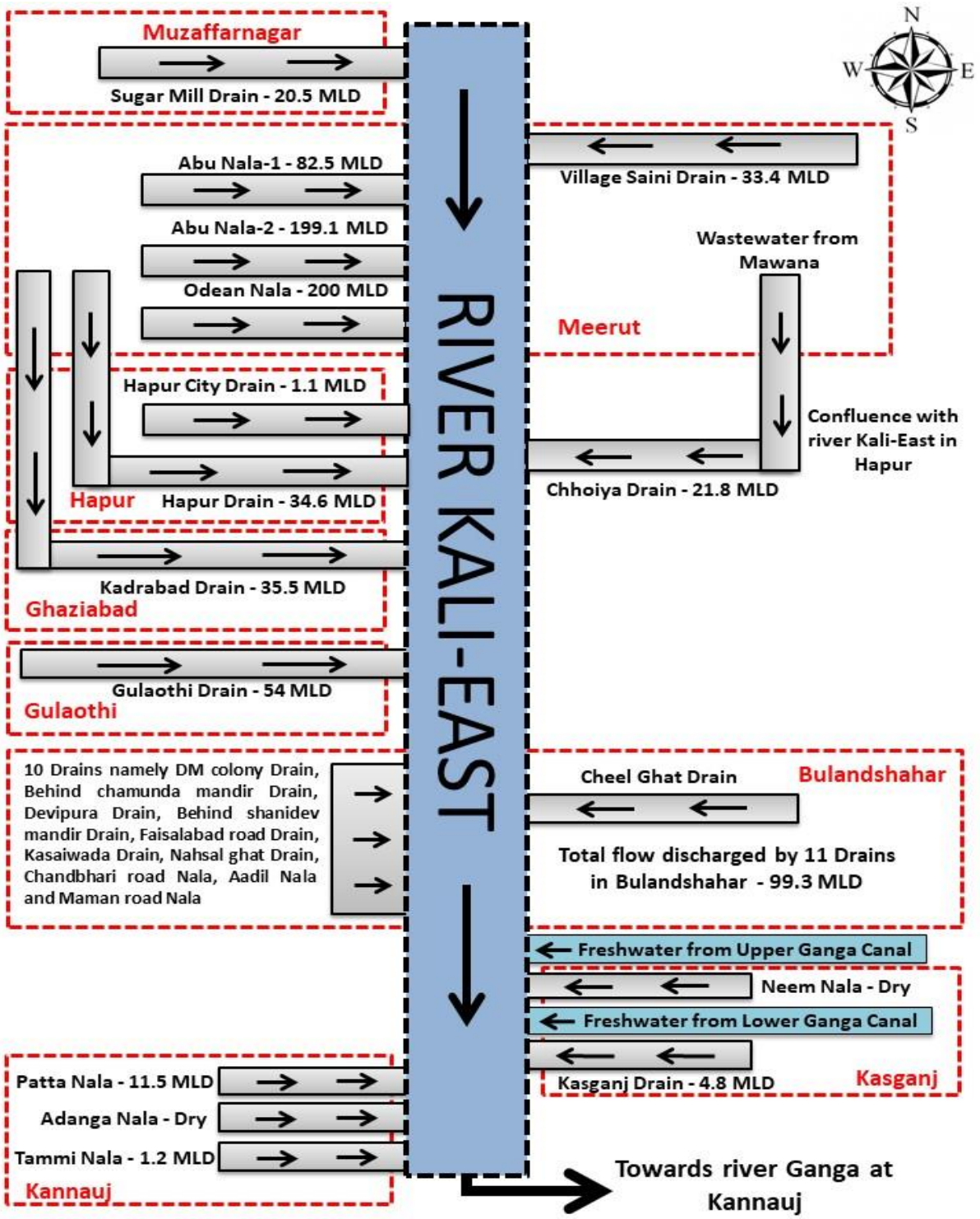


Figure 30 Schematic presentation of district-wise wastewater discharged by drains in to river Kali-East during pre-monsoon 2019

4.3 Sewage Generation and Treatment

The total sewage generated in the catchment area of the river Kali-East is 386 MLD. So far, the sewage treatment capacity developed in two cities is 181 MLD, out of which only 92 MLD is being utilized which is only 49% of installed capacity. Moreover, a gap of 76% is observed in sewage generation and sewage being treated. The district-wise generation of sewage in the catchment area of Kali-East is shown in **Figure 31**. There are 12 STPs in Meerut of 168 MLD of sewage treatment capacity and one STP in Kannauj of 13 MLD. The status of installed and utilized capacity of each STP is given in **Figure 32**. During monitoring, Lohia Nagar STP (10 MLD) in Meerut was found non-operational.

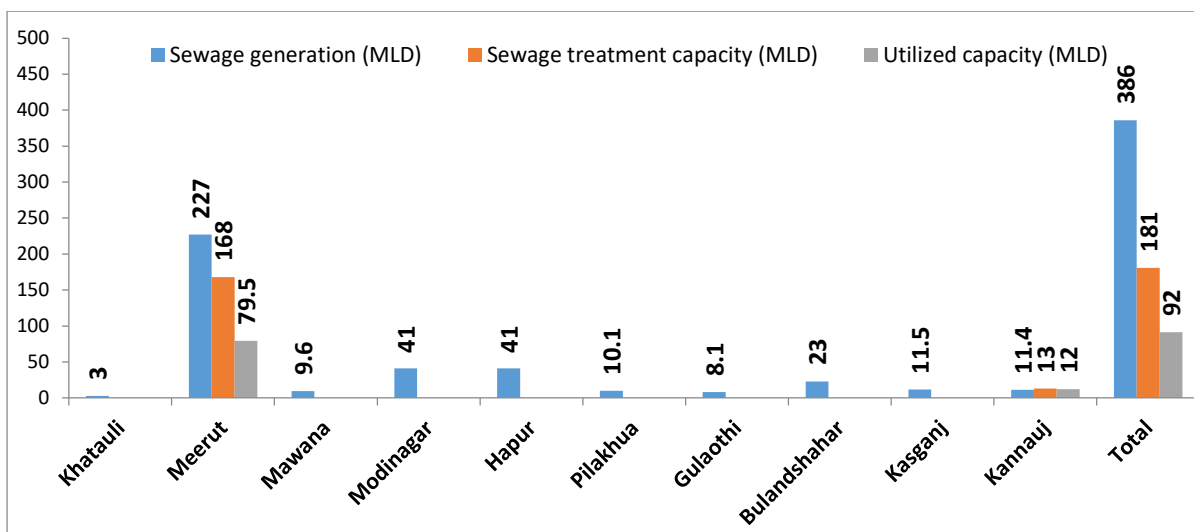


Figure 31 District-wise sewage generation and treatment in the catchment area of river Kali-East in the year 2019

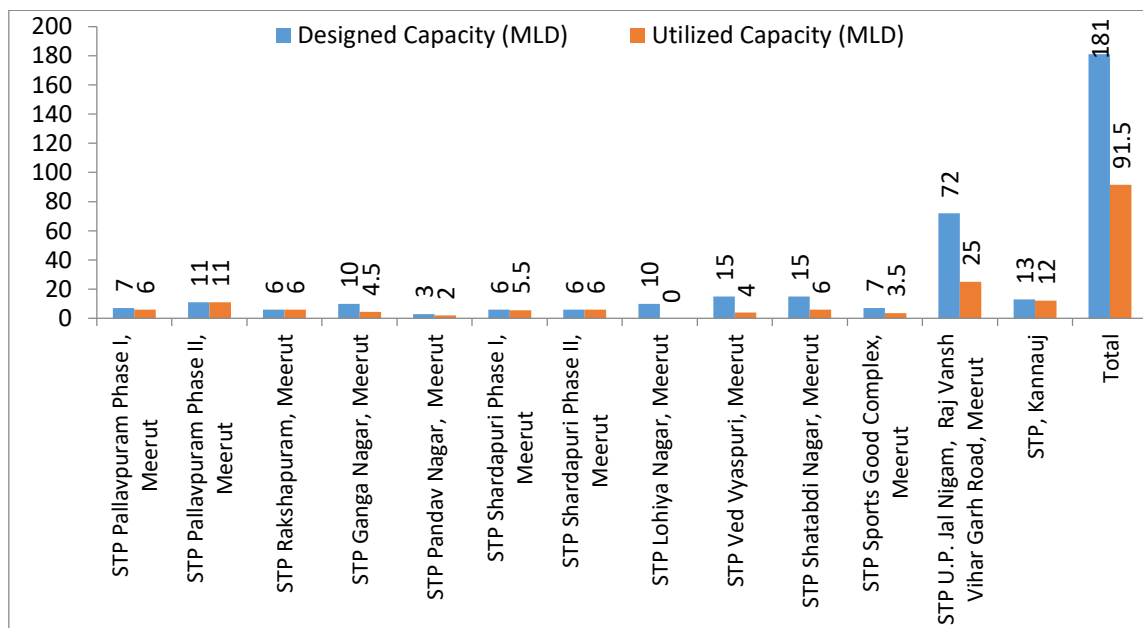


Figure 22 Gap between designed and utilized capacity of Sewage Treatment Plants (STPs)

4.4 Grossly Polluting Industries (GPIs) in the catchment area of the river Kali-East

There are 97 grossly polluting industries (GPIs) along the entire stretch of River Kali-East, which are classified under different sectors, namely, chemical (3), distillery and breweries (8), food, dairy, and beverages (16), pulp and paper (18), slaughter house (5), sugar (12), textile (34) and other (01). The sector-wise and district wise distribution status of GPIs in the catchment area of river Kali-East is shown in **Figure 33**.

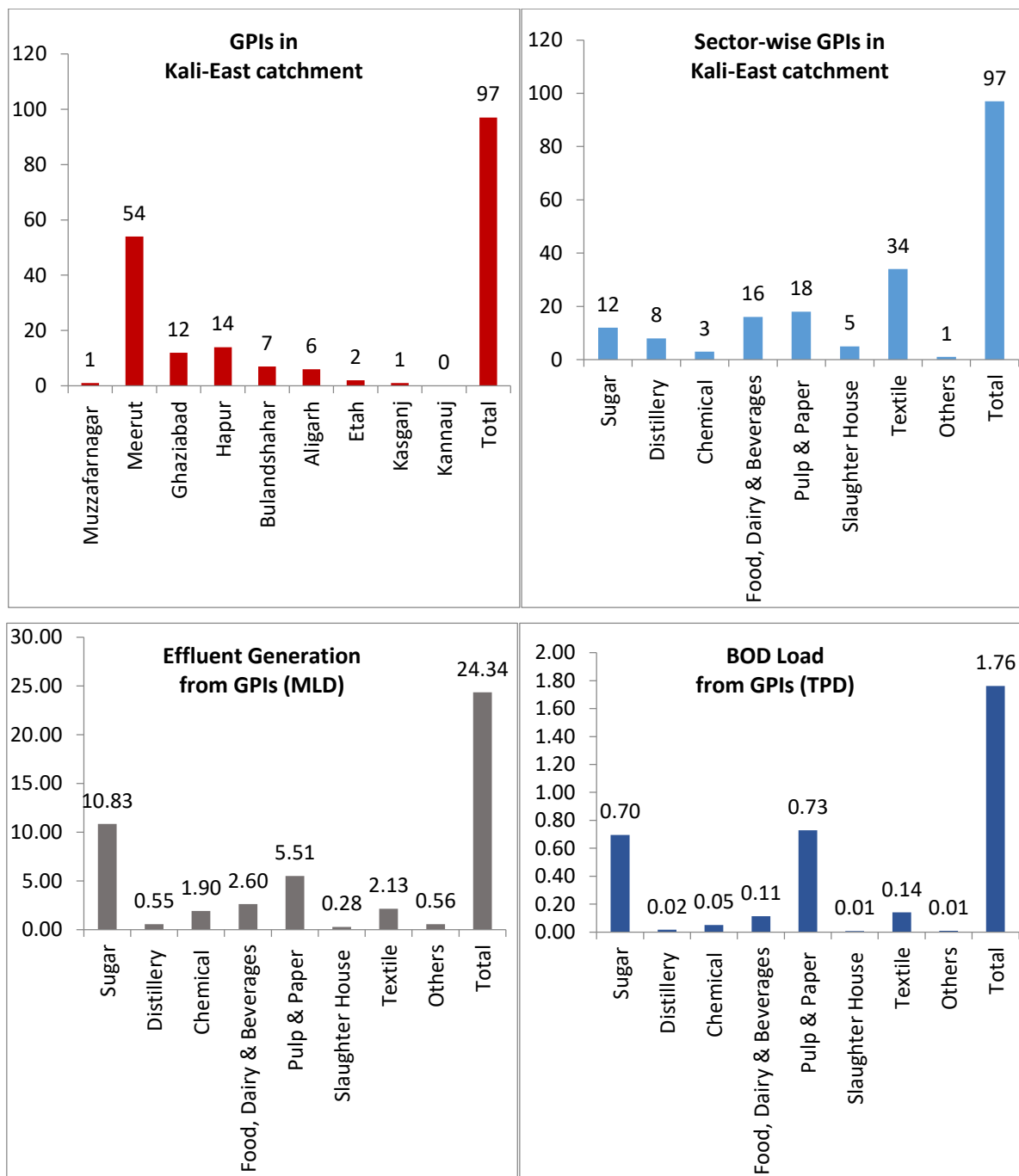


Figure 33 Sector-wise and district wise status of GPIs (in 2019) in the catchment area of river Kali-East

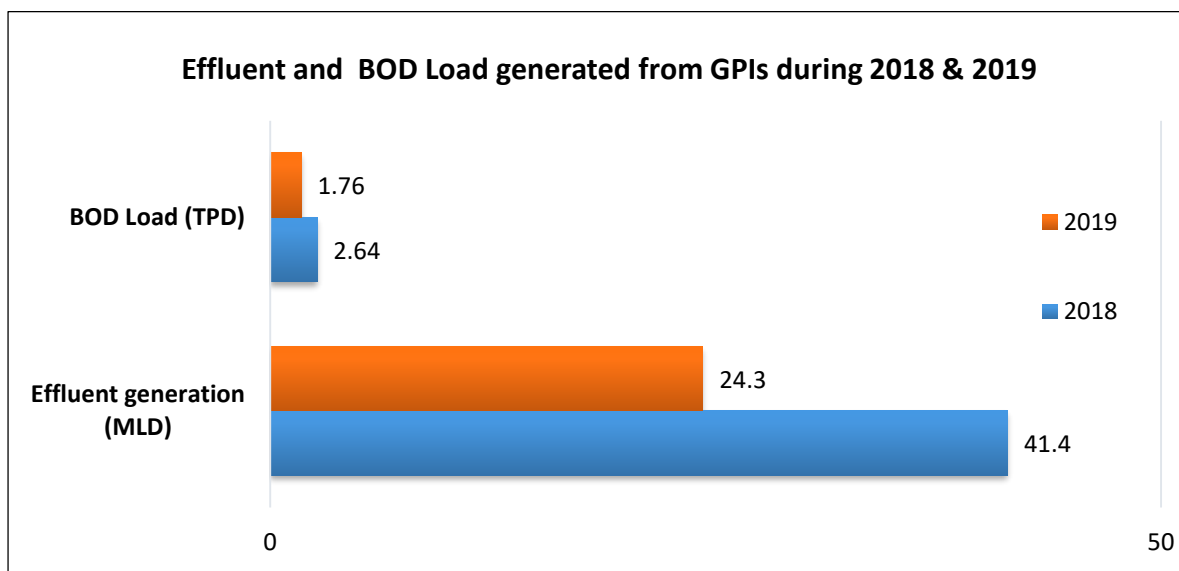


Figure 34 Sector-wise and district wise status of GPIs (in 2019) in the catchment area of river Kali-East

The total BOD load contributed by GPIs as per 2019 inspection is 1.76 TPD, out of which 81% is from Sugar and pulp and paper units. Except sugar industries, all other industries operate throughout the year. In comparison of 2018 inspection, during 2019 inspections of GPIs a significant reduction in effluent and BOD load generation has been observed and status of both years is shown in **Figure 34**.

There is a common effluent treatment plant (CETP) of 2.1 MLD capacity in Pilakhua (Hapur) and member units are textile units, which also discharges into river Kali-East through Kadrabad drain. **The CETP was found non-complying with the prescribed standards at the time of inspection carried out on 30.05.2019.** Thus, it can be stated that there is a high pollution load on river Kali-East which can be attributed to the pollution load from the industries as well as domestic discharge.

For ease of understanding and to identify the pollution sources, GPIs in the catchment area of river Kali-East are given in **Annexure-III**.

5. CONCLUSION

The study reveals that the river stretch from Muzaffarnagar to Bulandshahar (~ 150 km) is highly polluted owing to industrial and domestic discharge either directly or through drains. DO was found NIL during pre-monsoon season 2019 in the river stretch from Muzaffarnagar

to Bulandshahar. In this stretch, the BOD in the river water varied between 33 and 410 mg/l. The total pollution load and wastewater discharged by 26 drains in entire stretch was 148.1 TPD and 799.6 MLD, respectively, during pre-monsoon 2019, out of which 99.5% BOD Load 98% and wastewater is discharged in the stretch of Muzaffarnagar to Bulandshahar. Most of the drains in this stretch are mixed, carrying both industrial and domestic discharge. There are few towns/cities and industries in the stretch beyond Bulandshahar, and therefore, water quality was improved.

An increase in DO level was observed after getting fresh water from the upper Ganga canal near Khurja and from lower Ganga canal near Nadrai Bridge, upstream of Kasganj town. There is a significant gap between sewage generation and sewage being treated viz, almost 79%.

The comprehensive study revealed that the river stretch from Muzaffarnagar to Bulandshahar is almost dead due to lack of fresh water and discharge of industrial and domestic wastewater either directly or through drains.

6. MEASURES TAKEN FOR RESTORATION OF RIVER QUALITY

CPCB suggested following measures to State agencies (UPPCB, SMCG and U.P. Jal Nigam) for the improvement of river water quality:

1. There should be a single committee at the district level to monitor the action plan and to take suitable remedial measures.
2. UPPCB shall take quick action against non-complying GPIs in the catchment of river Kali-East for sending notices and imposing environmental compensation.
3. UPPCB shall ensure that no industry disposes colored effluent into any drain so that river Kali-East does not receive any colored effluent.
4. UPPCB shall ensure installation of wire net/geo-net at confluence point of drains.
5. UPPCB shall regularly monitor compliance of industries and grant Consent-To-Operate to industries having requisite effluent treatment facilities and complying with the prescribed standards and ensure that no industrial unit operates without having valid Consent-To-Operate and industries operating without consents should be closed down.
6. UPPCB shall fix water quality objectives of the non-perennial river for meeting the targeted quality within the prescribed time-frame at the confluence of each drain and follow up action shall be made.

7. UPPCB shall identify the sources of pollution and ascertain reasons for high color, high BOD and total coliforms in river Kali-East and shall take appropriate action for abatement and control of pollution in river Kali-East.
8. UPPCB shall formulate a time bound action plan in consultation with Uttar Pradesh Jal Nigam (UPJN), district administrations, municipal corporations, development authorities and other concerned bodies located in river Kali-East catchment for restoration of water quality of river Kali-East.
9. UPPCB and District Administration shall constitute a committee at district level for each district of Kali-East under chairmanship of District Magistrate having representative from UPPCB and other stakeholders to review the progress of implementation status of action plan and committees shall submit quarterly progress report to CPCB.
10. In absence of conventional treatment technology interim treatment solution such as bioremediation/or phytoremediation or any other remediation measures should be opted in drains and in river d/s location of confluence points. UPPCB may organise meetings at District level with stake holders for development of action plan and submit action plan to CPCB for adoption of interim treatment technology such as bioremediation/or phytoremediation or constructed wetland in drains which are not completely tapped or intercepted.

Hon'ble NGT has also passed many orders for restoration of river water quality and suggested to use alternative treatment technologies in absence of conventional treatment technologies. As per NGT order dated 22.08.2019 in O. A. 200/2014 regarding prevention and remediation of the pollution of river Ganga, the following was stated:

“Prevention of discharge of untreated industrial waste and sewage in the River Ganga and its tributaries, including the tapping of drains and bio-remediation, as applicable. Wherever STPs are not operating, immediate bioremediation and/or phytoremediation may be undertaken if feasible”.

“All the authorities have to be stringent and depict zero tolerance to the pollution of River Ganga. Wherever STPs are not operating, immediate bioremediation and/or phyto remediation may be undertaken if feasible. Wherever the work has not commenced, it is necessary that no untreated sewage is discharged into the River Ganga. Bioremediation and/or phytoremediation or any other remediation measures may start as an interim measure positively from 01.11.2019”

Considering the above directions, literature has been reviewed to identify technology for rejuvenation of river Kali-East and a series of in-situ, horizontal flow, free surface constructed

wetland systems along with Bio-diversity park which involve the in-situ remediation are selected for revival of river. The key outcome indicators of the Biodiversity Parks including the constructed wetland system in the river systems are as follows:

- Enhancement of DO from zero to more than 5 mg/l (upto 8.5 mg/l).
- Reduction of BOD from 400 mg/l to <10 mg/l.
- Reduction of COD from high levels to the levels below the permissible limit.
- Reduction of total pollution load from high levels to below permissible limit.
- Appearance of aerobic microbial communities and high densities of phyto- and zoo-planktons and also invertebrates.
- Change in the trophic structure and community.

CPCB along with Prof. C.R. Babu CEMDE, University of Delhi and officials of the UPPCB and Irrigation Department, Govt. of U.P carried out a survey of River Kali-East during Nov, 2019. Based on the survey, CPCB has prepared an action plan for restoration of water quality of river Kali-East through in-situ remediation which comprises constructed wetlands at 08 locations and Biodiversity Parks at 04 locations in the stretch from Khatauli to Bulandshahar. The action plan has been forwarded to Urban Development Department of Govt. of Uttar Pradesh and NMCG for implementation. NMGC sanctioned fund to Irrigation Department of Uttar Pradesh Govt. for preparation of DPR for civil work. Suggested constructed wetland sites and Biodiversity parks in the stretch of river Kali-East are shown in **Figure 35**.

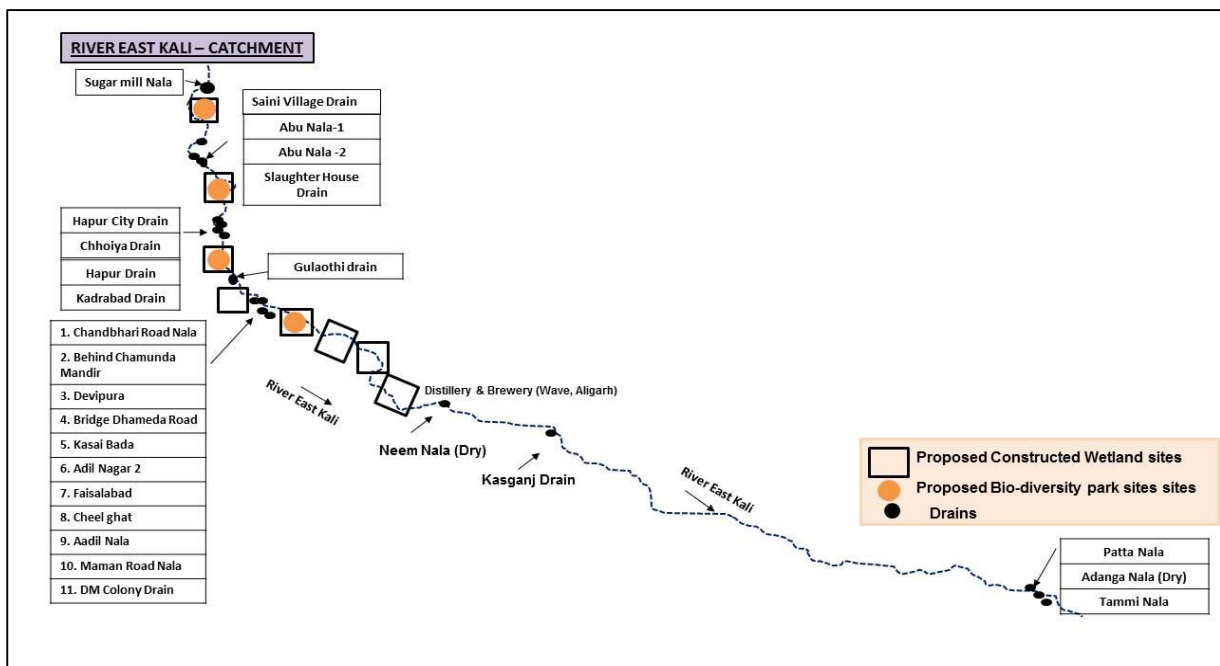


Figure 35 Proposed wetland sites (08) and Bio-diversity Parks (04) in the catchment area of the river Kali-East

Water quality data of General Parameters of river Kali-East (Pre-monsoon 2019)

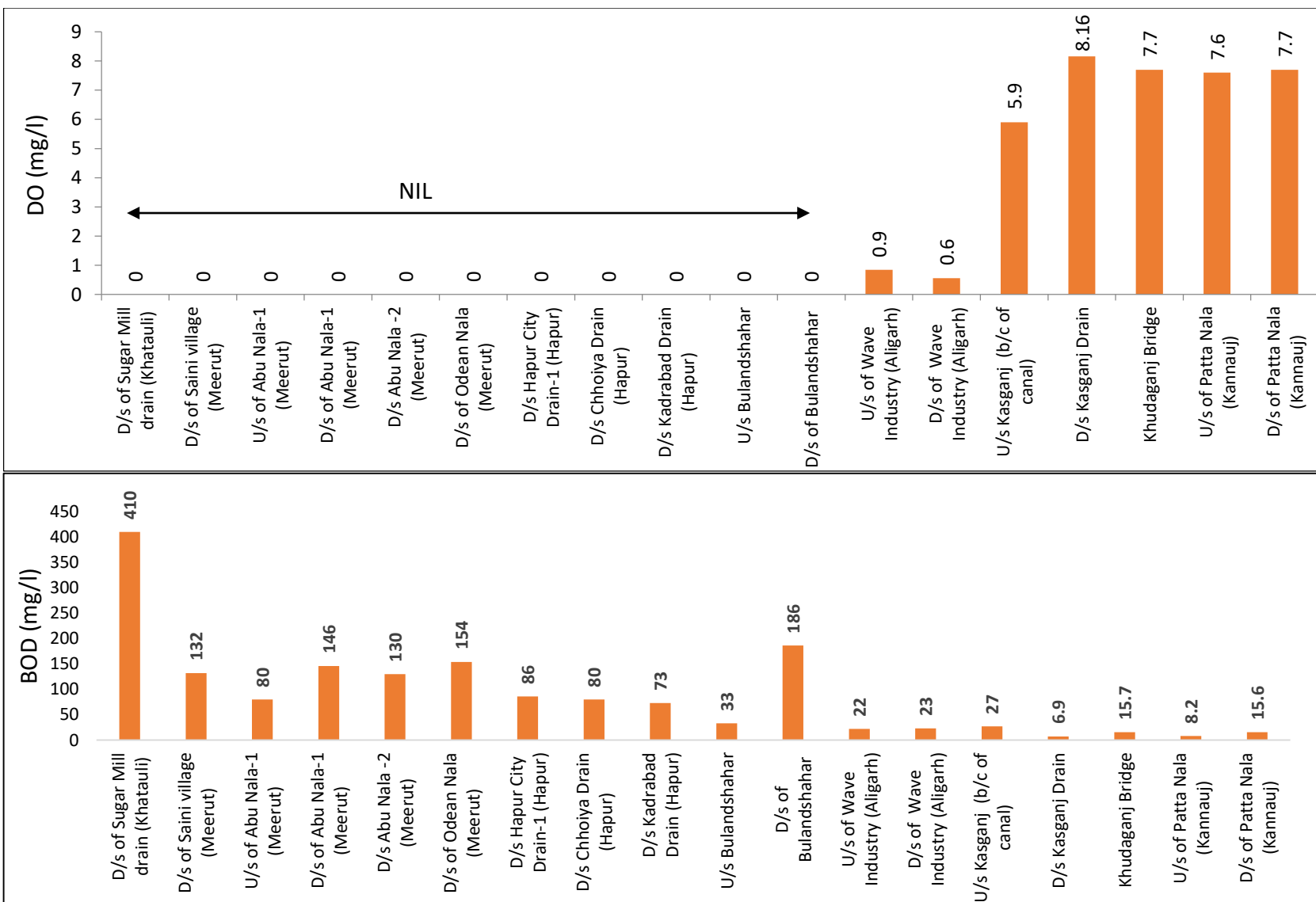
S. no.	River Location	Color	pH	DO	BOD	COD	TSS	TDS	Cl ⁻	NH ₃ -N	NO ₃ -N	PO ₄ -P	SO ₄ -S	TC	FC
1.	U/s of Sugar mill Drain	Dry													
2.	D/s of Sugar Mill Drain	30	4.9	0	410	1070	259	1094	142	3.9	1.6	2.2	na	28 × 10 ³	14 × 10 ³
3.	D/s of Muzaffarnagar-Khatauli near Khadli Village	51	7.3	0	78	167	88	1120	199	13.5	4.4	4.19	na	7 × 10 ⁵	22 × 10 ⁴
4.	U/s of Vill. Saini	Dry													
5.	D/s of Vill. Saini	BDL	6.7	0	132	421	254	2536	845	13.4	2.2	1.02	na	46 × 10 ⁵	31 × 10 ⁵
6.	U/s of Abu Nala-1	BDL	7.2	0	80	246	132	2376	781	12.6	1.4	1.14	na	22 × 10 ⁴	45 × 10 ³
7.	D/s of Abu Nala-1	BDL	7.6	0	146	289	177	1176	316	77.4	3.9	3.42	na	16 × 10 ⁶	92 × 10 ⁵
8.	D/s of Abu Nala-2	BDL	7.1	0	130	375	411	708	113	27.2	0.8	3.41	na	54 × 10 ⁷	22 × 10 ⁷
9.	D/s of Odean Nala	BDL	7	0	154	474	765	608	96	29.7	0.6	3.8	na	2 × 10 ⁹	17 × 10 ⁷
10.	U/s of Hapur City Drain	178	7.2	0	86	1074	226	752	118	49	2.4	4.1	na	11 × 10 ⁶	11 × 10 ⁶
11.	U/s of Chhoiya Drain	200	7.3	0	80	778	466	804	121	54.2	1.4	4.9	na	13 × 10 ⁸	34 × 10 ⁷
12.	D/s of Chhoiya Drain	143	7.2	0	49	555	280	752	126	64	2.5	4.52	na	49 × 10 ⁶	49 × 10 ⁶
13.	D/s of Hapur Drain	154	7.3	0	92	469	265	836	146	55.8	2.6	5.2	na	33 × 10 ⁵	33 × 10 ⁵
14.	D/s of Kadrabad Drain	173	7.3	0	73	567	384	960	165	47.8	2.8	5	na	78 × 10 ⁵	2 × 10 ⁶
15.	D/s of Gulaothi Drain	BDL	7.5	0	78	209	206	828	146	30.8	1.5	3.25	14	94 × 10 ⁵	94 × 10 ⁵
16.	U/s of Bulandshahar Drains	BDL	7.4	0	33	114	92	844	171	29.5	1	3.4	14	22 × 10 ⁵	13 × 10 ⁵
17.	U/s of Devipura Drain	BDL	7.4	0	45	219	308	816	156	26.7	1.5	3.35	17	22 × 10 ⁵	79 × 10 ⁴
18.	D/s of Devipura Drain	BDL	7.4	0	52	135	72	820	142	37.6	1.5	3.57	18	38 × 10 ⁶	12 × 10 ⁶
19.	D/s of Bulandshahar Drains	BDL	7.3	0	186	1409	-	870	127	32.6	1.5	3.82	18	16 × 10 ⁶	54 × 10 ⁵
20.	U/s of Wave Distilleries, Aligarh	BDL	7.6	0.85	22	76	48	870	160	33.3	0.1	4.42	21	35 × 10 ³	17 × 10 ³
21.	D/s of Wave Distilleries, Aligarh	BDL	7.6	0.56	23	67	38	848	158	31.7	0.2	4.42	19	24 × 10 ⁴	24 × 10 ⁴
22.	D/s of Neem Nala	BDL	6.6	5.71	28	111	98	1108	394	27.1	5.8	1.59	16	13 × 10 ³	34 × 10 ²
23.	U/s of Kasganj Drain	BDL	7.2	5.9	27	43	72	294	59	6.2	0.4	0.39	21	790	490
24.	D/s of Kasganj Drain	BDL	7	8.16	6.9	22	74	180	27	2.6	0.3	0.24	12	13 × 10 ³	93 × 10 ²
25.	At Khudaganj bridge	80	8.65	7.7	15.7	61.9	na	316	40.4	1.5	3.41	0.62	27.7	3.3 × 10 ⁴	2 × 10 ³
26.	U/s of Patta Nala	70	8.28	7.6	8.2	50.3	na	415	75	3.3	3.89	0.72	22.9	3.3 × 10 ⁵	3.3 × 10 ⁴
27.	D/s of Patta Nala	60	8.07	7.7	15.6	57.2	na	504	75	2.2	3.12	0.71	52.1	1.6 × 10 ⁷	2.4 × 10 ⁶
28.	River Ganga a/c with river Kali-East	20	8.7	7.4	6.6	30.3	na	245	30.8	1.7	1.36	0.22	26.8	7.8 × 10 ³	4.5 × 10 ³

All the parameters are expressed in mg/l except pH, Color (Hazen), TC (MPN/100 ml) and FC (MPN/100 ml), na-not analyzed

Water quality data of Trace Metals of river Kali-East (Pre-monsoon 2019)

S. no.	River Location	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn	Sb	Co	Se	V
1.	U/s of Sugar mill Drain	Dry													
2.	D/s of Sugar Mill Drain	BDL	BDL	0.02	0.08	15.7	0.11	0.28	0.01	na	0.14	BDL	BDL	BDL	BDL
3.	D/s of Muzaffarnagar-Khatauli near Khadli Village	BDL	BDL	BDL	BDL	1.96	BDL	0.25	BDL	na	0.02	BDL	BDL	BDL	BDL
4.	U/s of Vill. Saini	Dry													
5.	D/s of Vill. Saini	BDL	BDL	BDL	0.02	1.75	0.01	0.21	BDL	na	0.07	BDL	BDL	BDL	BDL
6.	U/s of Abu Nala-1	BDL	BDL	BDL	0.01	0.73	BDL	0.13	BDL	na	0.06	BDL	BDL	BDL	BDL
7.	D/s of Abu Nala-1	BDL	BDL	BDL	0.13	2.87	0.02	0.17	BDL	na	0.1	BDL	BDL	BDL	BDL
8.	D/s of Abu Nala-2	BDL	0.15	0.09	0.36	10.52	0.09	0.32	0.11	BDL	1.02	BDL	BDL	BDL	BDL
9.	D/s of Odean Nala	BDL	0.05	0.05	0.25	11.32	0.07	0.29	0.05	na	0.65	BDL	BDL	BDL	0.06
10.	U/s of Hapur City Drain	BDL	0.02	0.03	0.09	3.46	0.03	0.24	0.03	BDL	0.28	BDL	BDL	BDL	BDL
11.	U/s Chhoiya Drain	BDL	0.03	0.04	0.13	5.17	0.03	0.25	0.04	BDL	0.42	BDL	BDL	BDL	BDL
12.	D/s of Chhoiya Drain	BDL	0.04	0.06	0.17	7.44	0.05	0.28	0.05	BDL	0.5	BDL	BDL	BDL	BDL
13.	D/s of Hapur Drain	BDL	0.02	0.03	0.1	4.19	0.03	0.25	0.03	na	0.3	BDL	BDL	BDL	BDL
14.	D/s of Kadrabad Drain	BDL	0.02	0.03	0.08	3.89	0.02	0.26	0.02	BDL	BDL	BDL	BDL	BDL	0.06
15.	D/s of Gulaothi Drain	BDL	0.02	0.02	0.07	3.63	0.02	0.22	0.02	BDL	0.22	BDL	BDL	BDL	BDL
16.	U/s of Bulandshahar Drains	BDL	BDL	BDL	0.03	1.82	BDL	0.21	BDL	BDL	0.13	BDL	BDL	BDL	BDL
17.	U/s of Devipura Drain	BDL	0.02	0.03	0.11	7.31	0.03	0.29	0.03	BDL	0.32	BDL	BDL	BDL	0.05
18.	D/s of Devipura Drains	BDL	BDL	BDL	0.03	1.15	0.01	0.21	BDL	0.11	BDL	BDL	BDL	BDL	BDL
19.	D/s of Bulandshahar Drains	BDL	0.1	0.19	0.77	67.6	0.32	0.89	0.17	BDL	1.96	BDL	0.03	BDL	0.17
20.	U/s of Wave Distilleries and Breweries, Aligarh	BDL	BDL	BDL	BDL	1.16	BDL	0.26	BDL	na	0.03	BDL	BDL	BDL	BDL
21.	D/s of Wave Distilleries and Breweries, Aligarh	BDL	BDL	BDL	BDL	1.08	BDL	0.33	BDL	na	0.04	BDL	BDL	BDL	BDL
22.	D/s of Neem Nala	BDL	BDL	BDL	BDL	2.38	BDL	0.31	BDL	na	BDL	0.01	BDL	BDL	BDL
23.	U/s of Kasganj Drain	BDL	BDL	BDL	BDL	1.69	BDL	0.09	BDL	na	0.01	BDL	BDL	BDL	BDL
24.	D/s of Kasganj Drain	BDL	BDL	BDL	BDL	3.33	BDL	0.1	BDL	na	0.02	BDL	BDL	BDL	BDL
25.	At Khudaganj bridge	BDL	BDL	BDL	na	na	BDL	na	0.12	na	na	na	na	na	na
26.	U/s of Patta Nala	BDL	BDL	BDL	na	na	BDL	na	0.08	na	na	na	na	na	na
27.	D/s of Patta Nala	BDL	0.01	BDL	na	na	BDL	na	0.08	na	na	na	na	na	na
28.	River Ganga a/c with river Kali-East	BDL	BDL	BDL	na	na	BDL	na	0.12	na	na	na	na	na	na
Drinking water standards (BIS 10500: 2012)	Requirement (Acceptable limit)	0.01	0.003	0.05	0.05	0.3	0.01	0.1	0.02	0.001	5	-	-	0.01	-
	Permissible limit in the absence of alternate source	0.05	0.003	0.05	1.5	0.3	0.01	0.3	0.02	0.001	15	-	-	0.01	-

All the parameters are expressed in mg/l; na-not analyzed



Variation of DO and BOD in river Kali-East during pre-monsoon 2019

Drain Data of General Parameters (Pre-monsoon 2019)

S. no.	Drains	Flow/Stagnant/Dry	Flow	Pollution Load	Pollution Source	Color	pH	BOD	COD	TSS	TDS	Cl ⁻	NH ₃ -N	NO ₃ -N	PO ₄ -P	SO ₄ -S
1.	Sugar Mill Nala	Flow	20.59	21.97	Mixed	52	5.07	1067	1752	946	1296	132	5	1.9	na	na
2.	Village Saini Drain	Flow	33.44	12.87	Mixed	317	7.78	385	893	346	2572	311	6	3.2	na	na
3.	Abu Nala-1	Flow	82.47	7.67	Mixed	120	7.88	93	405	215	1248	360	82	4.6	na	na
4.	Abu Nala-2	Flow	199.15	17.72	Mixed	87	6.48	89	401	265	780	95	39	1.5	na	na
5.	Odean Nala	Flow	200	62.2	Mixed	120	7.18	311	721	498	1008	140	14	2.9	na	na
6.	Hapur city Drain	Flow	1.16	0.09	Mixed	102	7.55	75	210	51	1004	118	28	3.7	na	na
7.	Choiya Drain	Flow	21.83	0.59	Mixed	70	7.87	27	119	48	1132	242	23	1.4	na	na
8.	Hapur Drain	Flow	34.56	2.32	Mixed	226	7.56	67	251	129	1136	213	35	2.5	na	na
9.	Kadradbad Drain	Flow	35.54	3.13	Mixed	166	7.59	88	226	54	1204	145	26	2.3	na	na
10.	Gulaothi Drain	Flow	54	8.1	Mixed	75	7.29	150	498	654	872	na	36	1.5	na	na
11.	DM colony Drain	Flow	3.46	0.24	Domestic	57	7.51	69	239	350	560	na	22	1.3	na	na
12.	Behind chamunda mandir Drain	Flow	20.74	1.85	Domestic	97	7.24	89	261	285	612	na	20	1.3	na	na
13.	Devipura Drain	Stagnant	Not Measurable	-	Domestic	70	7.35	92	245	139	672	na	21	1.4	na	na
14.	Behind shanidev mandir Drain	Covered by Municipal Solid Waste	Not Measurable	-	Domestic	37	8.19	54	194	224	660	na	14	0.7	na	na
15.	Faisalabad road Drain	Flow	16.2	3.35	Mixed	114	7.12	207	482	227	1060	na	32	2.7	na	na
16.	Kasaiwada Drain	Not Measurable	-	-	Domestic	72	7.43	158	564	475	1104	na	17	1.6	na	na
17.	Nahsal ghat Drain	Flow	2.47	0.44	Domestic	87	7.66	178	575	478	828	na	12	1.9	na	na
18.	Cheel ghat Drain	Flow	3.46	0.16	Domestic	187	7.64	46	160	96	1012	na	24	1	na	na
19.	Chandbhari road Nala	Flow	5.6	0.97	Domestic	97	7.11	173	597	503	1016	na	26	2.7	na	na
20.	Aadil Nala	Flow	11.37	1.66	Domestic	81	7.32	146	411	463	848	na	20	1.9	na	na
21.	Maman road Nala	Flow	36	2.02	Mixed	76	7.31	56	201	483	552	na	21	0.8	na	na
22.	Neem Nala	Dry	-	-	Domestic	-	-	-	-	-	-	-	-	-	-	-
23.	Kasganj Drain	Flow	4.84	0.38	Domestic	67	7.13	78	221	98	700	121	24	1.5	na	na
24.	Patta Nala	Flow	11.47	0.25	Domestic	50	7.66	21.8	104	58.1	780	117	23.3	1.8	2.7	102
25.	Adanga Nala	Dry	-	-	Domestic	-	-	-	-	-	-	-	-	-	-	-
26.	Tammi Nala	Flow	1.23	0.07	Domestic	50	7.35	53.2	183	376	702	88.4	20.3	1.58	2.48	104

All the parameters are expressed in mg/L except Flow (MLD), Pollution load (TPD), pH, Color (Hazen), TC (MPN/100 ml) and FC (MPN/100 ml); na-not analysed

Note: Flow of drains was measured by float method. The factor of 0.8 is the average velocity in such drains for the depth of flow and therefore was used. As per CPHEEO, the average flow in domestic drains can be calculated from the peak flow by using a factor dependent upon the contributing population to the recipient drain.

Drain Data of Trace Metals (Pre-monsoon 2019)

S. no.	Drains	As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Hg	Zn	Sb	Co	Se	V
1.	Sugar mill Nala	BDL	BDL	0.03	0.10	19.84	0.16	0.30	0.02	na	0.20	BDL	BDL	BDL	BDL
2.	Village Saini Drain	BDL	BDL	0.02	0.04	0.84	0.02	0.12	0.01	na	0.09	BDL	BDL	BDL	BDL
3.	Abu Nala-1	BDL	BDL	BDL	0.13	2.87	0.02	0.17	BDL	na	0.10	BDL	BDL	BDL	BDL
4.	Abu Nala-2	BDL	0.01	0.02	0.12	5.38	0.04	0.20	0.02	na	0.31	BDL	BDL	BDL	BDL
5.	Odean Nala	BDL	0.01	0.33	0.13	6.18	0.04	0.22	0.02	na	0.32	BDL	BDL	BDL	BDL
6.	Hapur city Drain	0.01	BDL	BDL	BDL	BDL	BDL	0.12	BDL	BDL	BDL	BDL	BDL	BDL	BDL
7.	Chhoiya Drain	0.01	BDL	BDL	BDL	1.21	BDL	0.23	BDL	BDL	0.07	BDL	BDL	BDL	BDL
8.	Hapur Drain	BDL	BDL	0.01	0.05	1.61	0.02	0.29	BDL	BDL	0.15	BDL	BDL	BDL	0.07
9.	Kadhrabad Drain	BDL	BDL	BDL	0.02	0.75	BDL	0.20	BDL	BDL	0.05	BDL	BDL	BDL	BDL
10.	Gulaothi Drain	BDL	BDL	0.01	0.06	4.33	0.05	0.26	BDL	BDL	0.22	BDL	BDL	BDL	0.06
11.	DM colony Drain	BDL	BDL	0.03	0.05	14.96	0.03	0.40	0.01	BDL	0.23	BDL	BDL	BDL	0.07
12.	Behind chamunda mandir Drain	BDL	BDL	0.01	0.04	5.85	0.06	0.23	BDL	BDL	0.20	BDL	BDL	BDL	0.05
13.	Devipura Drain	BDL	BDL	BDL	0.04	1.52	0.02	0.20	BDL	BDL	0.13	BDL	BDL	BDL	BDL
14.	Behind shanidev mandir Drain	BDL	BDL	0.04	0.03	4.49	0.10	0.18	BDL	na	0.14	BDL	BDL	BDL	0.06
15.	Faisalabad road Drain	BDL	BDL	0.07	0.13	4.78	0.11	0.27	0.11	BDL	0.28	BDL	BDL	BDL	0.06
16.	Kasaiwada Drain	BDL	BDL	0.03	0.23	9.19	0.13	0.42	0.02	BDL	0.38	BDL	BDL	BDL	0.08
17.	Nahsal ghat Drain	BDL	0.10	0.10	0.05	3.47	0.08	0.24	BDL	BDL	0.59	BDL	BDL	BDL	0.06
18.	Cheel ghat Drain	BDL	BDL	BDL	0.02	1.62	0.01	0.23	BDL	BDL	0.07	BDL	BDL	BDL	BDL
19.	Chandbhari road Nala	BDL	BDL	BDL	0.04	3.37	0.01	0.27	BDL	na	0.17	BDL	BDL	BDL	0.06
20.	Aadil Nala	BDL	BDL	0.02	0.08	7.48	0.04	0.55	0.03	na	0.24	BDL	BDL	BDL	0.06
21.	Maman road Nala	BDL	BDL	BDL	0.06	4.33	0.03	0.17	BDL	BDL	0.13	BDL	BDL	BDL	0.05
22.	Neem Nala	Dry													
23.	Kasganj Drain	BDL	BDL	BDL	0.02	1.39	0.02	0.18	BDL	na	0.07	BDL	BDL	BDL	BDL
24.	Patta Nala	BDL	BDL	BDL	BDL	0.66	BDL	0.14	0.26	na	BDL	BDL	BDL	BDL	BDL
25.	Adanga Nala	Dry													
26.	Tammi Nala	BDL	BDL	BDL	BDL	0.56	BDL	0.18	0.37	na	0.14	BDL	BDL	BDL	BDL

All the parameters are expressed in mg/l.

BDL-Below detection limit

Na-not analysed

Drain Data of Pesticides (Pre-monsoon 2019)

S. no.	Drains	α -HCH	β -HCH	γ -HCH	δ -HCH	Aldrin	Dieldrin	α -Endosulfan	β -Endosulfan	OP'DDT	PP'DDT	pp'DDE	Monochrotophos	Dimethoate	Methyl Parathion	Malathion	Chloropyriphos	Ethion
1.	Sugar mill Nala	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2.	Village saini Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
3.	Abu Nala-1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
4.	Abu Nala-2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
5.	Odean Nala	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
6.	Hapur city Drain	0.05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL	0.05
7.	Chhoiya Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8.	Hapur Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
9.	Kadrabad Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
10.	Gulaothi Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
11.	DM colony Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
12.	Behind chamunda mandir Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
13.	Devipura Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
14.	Behind shanidev mandir Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
15.	Faisalabad road Drain	0.06	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.06
16.	Kasaiwada Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
17.	Nahsal ghat Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18.	Cheel ghat Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
19.	Chandbhari road Nala	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20.	Aadil Nala	0.05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
21.	Maman road Nala	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
22.	Neem Nala	Dry																
23.	Kasganj Drain	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
24.	Patta Nala	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
25.	Adanga Nala	Dry																
26.	Tammi Nala	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

All the parameters are expressed in $\mu\text{g/l}$; BDL-Below detection limit

List of GPIs in the catchment area of river Kali-East (2019)

S. no	Stretch of River	No. of GPIs	Detail of GPIs
1.	Origin to Confluence of Sugar Mill Nala	01	1. M/s Triveni Engineering Industries Ltd., Khatauli (Sugar Mill)
2.	D/s Sugar Mill Nala to D/s Saini Village, Meerut	08	<p>GPIs in Catchment of Kali-East (Saini Village), Meerut</p> <ol style="list-style-type: none"> 1. Devpriya Industries, Unit - I, Mawana Road, Meerut 2. Devpriya papers Pvt Ltd., Mawana Road, Meerut 3. Devpriya Products Ltd. Unit-1(Kraft & Duplex), Mawana Road, Meerut 4. Devpriya Industries Ltd. Unit-Ii (Kraft & Duplex), Mawana Road, Meerut 5. New Bonanza India Ltd., Meerut-Mawana Road, Meerut <p>GPIs in Catchment of Saini Village drain (Saini Village), Meerut</p> <ol style="list-style-type: none"> 1. Anand Duplex Ltd, unit - I Meerut-Mawana Road, Meerut 2. Anand Duplex Ltd, unit – II, Meerut-Mawana Road, Meerut 3. Anand Triplex Board Ltd., Meerut-Mawana Road, Meerut
3.	D/s Saini Village to D/s Odean Nala (D/s Meerut)	19	<p>GPIs in Catchment of Abu Nala-1 (Sakoti, Daurala & Meerut)</p> <ol style="list-style-type: none"> 1. United Sprits Ltd., Distillery Unit, Meerut Cantt, Meerut 2. Sab Miller Distillery, Meerut Cantt, Meerut 3. Indian Potash Ltd, Sakauti Tanda, Muzaffarnagar Road, Meerut 4. Daurala Organics Ltd.), Daurala, Meerut 5. Daurala Sugar Works, Chemical Unit, Daurala, Meerut 6. Daurala Sugar Works, Distillery Unit, Daurala, Meerut 7. Daurala Sugar Works, Sugar Unit, Daurala, Meerut 8. Continental India Pvt. Ltd., NH-58, Modipuram, Meerut, Uttar Pradesh

S. no	Stretch of River	No. of GPIs	Detail of GPIs
			<p>GPIs in Catchment of Abu Nala-2 (Meerut)</p> <ol style="list-style-type: none"> 1. Ashoka Handloom, Garh Road, Meerut 2. Pashupati Textiles, Garh Road, Meerut 3. U.P. Dying & Printing Works, 68 Navchandi Ground, Meerut 4. SGS Prints (Shilpy Handfab Pvt. Ltd), Garh Road, Meerut 5. Loothara Handloom Pvt. Ltd, Gangol Road, Meerut <p>GPIs in Catchment of Odean Nala (Meerut)</p> <ol style="list-style-type: none"> 1. Modern Process House, Mohakampur, Meerut 2. National Handloom, Mohkampur, Meerut 3. Ashoka Handloom Ind-1, Shyam Nagar, Meerut <p>GPIs in Catchment of Kali-East (Meerut)</p> <ol style="list-style-type: none"> 1. Al – Faheem Meatex Pvt. Ltd., Alipur, Hapur Road, Meerut 2. Al – Saqib Exports Pvt. Ltd., Alipur, Hapur Road, Meerut 3. Tanya Marketing Pvt. Ltd., Alipur, Jijmana Hapur Road, Meerut
4.	D/s Odean Nala to Confluence of Chhoiya Nala, Meerut	05	<p>GPIs in Catchment of Chhoiya Nala (Meerut & Mawana)</p> <ol style="list-style-type: none"> 1. Sangal Papers Ltd., Meerut-Mawana Road, Meerut 2. Mawana Sugar Works, Mawana, Meerut 3. Nanglamal Sugar Complex, Distillery Unit, Nanglamal, Meerut 4. Nanglamal Sugar Complex, Sugar Unit, Nanglamal, Meerut 5. Anand Tissues Ltd., (Shree Venkatesh Paper Mill) Meerut Mawana Road, Meerut
5.	D/s Chhoiya Nala to Confluence of Gulaothi drain (This segment covers GPIs of Meerut, Hapur, Modinagar & Gulaothi)	50	<p>GPIs in Catchment of Kadrabad Drain (Hapur)</p> <ol style="list-style-type: none"> 1. S & S, P-61, Textile Centre Pilakhuwa, Hapur 2. Daily Foods, Modi Nagar Road, Hapur, U.P. 3. Shiv Shankar Cotton, P-70, Textile Centre Pilakhuwa, Hapur 4. Shiv Shankar Dyeing, P-74, Textile Centre Pilakhuwa, Hapur 5. Tirupati Handloom, P-67 & 68, Textile Centre Pilakhuwa, Hapur

S. no	Stretch of River	No. of GPIs	Detail of GPIs
			<p>6. Rrc Red Rose Thred Pvt. Ltd., P-16, 17 & 18, Textile Centre Pilakhuwa, Hapur</p> <p>7. Cta Apparals Pvt. Ltd., P-26, 27, 28 & 29, Textile Centre Pilakhuwa, Hapur</p> <p>8. Sushil Tech Pvt. Ltd., P-126, 125, P-16, 17 & 18, Textile Centre Pilakhuwa, Hapur</p> <p>9. R.K.B. Towel Mfg. Co. Ltd., (Formerly Control Textiles), Hapur Road Dasna, Distt--Hapur</p> <p>10. Keshav Industries, Khasra No. 290, Delhi-Garh Road, Dhaulana, Pilkhuwa</p> <p>11. Pilkhuwa Water Proofing Company, Jindal Nagar, Hapur</p> <p>12. Super Dyeing & Printing Works, Nh-24, Delhi-Hapur Road, Pilkhuwa, Hapur</p> <p>13. Shri calendering works, Partapur road Pilakhua, Hapur</p> <p>14. Merino Industries Ltd., Village- Achheja, P.O.-Hapur</p> <p>15. Mother Dairy Fruit & Vegetable Pvt. Ltd., 18 K.M. Stone, Pilakhua, Hapur</p> <p>16. Brijnathpur Sugar Mills, (Sugar Unit.), Vill-Brijnathpur, Hapur</p> <p>17. Brijnathpur Sugar Mills, (Distillery Unit), Vill-Brijnathpur, Hapur</p> <p>GPIs in Catchment of Kadrabad Drain (Meerut)</p> <p>1. Paswara Papers(P) Ltd, Mohiuddinpur, Delhi Road, Meerut</p> <p>2. Harbansh Dairy Pvt. Ltd., Meerut Road, Mohiuddinpur, Meerut, U.P.</p> <p>3. Harbansh Lal Food Pvt. Ltd. Meerut Road, Mohiuddinpur, Meerut, U.P.</p> <p>4. Alps Industries Ltd., Vill. -Aminagar, Bhoorbaral, Partapur, Meerut</p> <p>5. Up. State Sugar Corporation Ltd, Mohiuddinpur, Meerut</p> <p>GPIs in Catchment of Kadrabad Drain (Modinagar)</p> <p>1. Modi Distillery, Modi Nagar, Ghaziabad</p> <p>2. Modi Sugar Mills, Modi Nagar, Ghaziabad</p> <p>3. Ram Niwash Goyal & Sons, Sikheda Road, Modi Nagar, Ghaziabad</p> <p>4. Kripa Ram Dairy Pvt. Ltd., Village- Bhojpur, Tehsil- Modinagar, Ghaziabad</p>

S. no	Stretch of River	No. of GPIs	Detail of GPIs
			<p>5. Ved Cellulose Ltd., 16 Km. Stone, Hapur Road, Vill-Lakhan, P.O.-Galand, District-Ghaziabad.</p> <p>6. Modi Nagar Paper Mills, Modi Nagar, Ghaziabad</p> <p>7. Kartik fabrics Pvt. Ltd., Khasra no.184-185-186, Pawanpuri, Murad Nagar, Ghaziabad</p> <p>GPIs in Catchment of Hapur Drain (Meerut)</p> <p>1. Kanta Polytex P Ltd, By Pass Road, Vedvyas Puti, Meerut</p> <p>2. Loothara Handloom Pvt. Ltd, Gangol Road, Meerut</p> <p>3. Jyoti Industries (Changed Name S.S Textiles), E-86, Udyogpuram Partapur, Meerut</p> <p>4. Kamal Dying House, B-5, Udyogpuram, Meerut</p> <p>5. Raj Kumar Textiles, A-16 Udyogpuram, Meerut</p> <p>6. Rachit Prints, B-9,10,11 Udyogpuram, Meerut</p> <p>7. Shakun Handifab, Partapur, Meerut</p> <p>8. Anupam Processers, Partapur, Meerut</p> <p>9. Gangol Sahkari Dugdh Utpadak Sangh Ltd., Gangol Road, Partapur, Meerut, U.P.</p> <p>10. Kailash Dairy Ltd., Rithani, Delhi Road, Meerut, U.P</p> <p>11. Rama Tax Process House, Rithani, Meerut</p> <p>12. Shiva Fastners, Partapur, Meerut</p> <p>13. Janki News Print Pvt. Ltd. (Sumit Agro Products Ltd.) Panchali Baghpat Road, Meerut</p> <p>14. Star Kraft Papers Pvt. Ltd (Formerly known as Devstar Paper Pvt. Ltd. Panchali, Baghpat Road, Meerut)</p> <p>15. Kanav Paper Pvt. Ltd. (Bifurcated unit of Devpriya Fibers Pvt Ltd.), Vill. – Panchali, Baghpat Road, Meerut)</p> <p>16. Chamunda Paper Pvt. Ltd., Dheerkhera, Industrial Area, Meerut</p> <p>17. Solitare Foods Pvt. Ltd., Gangol Road, Khasra No. 376, Gangol Road Behind Shopia School, Partapur, Meerut, U.P</p> <p>GPIs in Catchment of Kali-East (Hapur)</p> <p>1. Raybon Foods P Ltd., Rampur Road, Hapur.</p> <p>2. Navbharat Duplex, Village Badnoulli, Modinagar Road, Hapur</p> <p>GPIs in Catchment of Gulaothi Drain</p> <p>1. V.R.S. Foods Ltd, (Unit-3), Old Bus Stand, Gulaothi, Bulandshahar</p>

S. no	Stretch of River	No. of GPIs	Detail of GPIs
			2. V.R.S. Foods Ltd, (Unit-4), Old Bus Stand, Gulaothi, Bulandshahar
6.	D/s Gulaothi to D/s Bulandshahar	05	<p>GPIs in Catchment of Drains of Bulandshahar and Kali-East</p> <p>Food and Dairy Industries</p> <p>1. Gopalji Dairy Foods Pvt. Ltd., Garh Road, Syana, Bulandshahar</p> <p>Sugar Industries</p> <p>1. Anamika Sugar Mills Pvt. Ltd., Agauta, Aurangabad, Bulandshahar</p> <p>2. Dhampur Sugar Mills Ltd. Vill. Rajpura, Teh. Gunnur, Distt: Badaun, Bulandshahar</p> <p>3. Triveni Engineering & Industries Ltd. (Sugar Unit) Vill. Sabitgarh, Khurja, Bulandshahar</p> <p>4. Wave Industries Ltd., (Sugar Unit). Panni Nagar, Bulandshahar</p>
7.	D/s Bulandshahar to Aligarh region	06	<p>GPIs in Catchment of Kali-East (Aligarh Region)</p> <p>1. Hind Agro Industries Ltd., Anupshahar Road, Aligarh</p> <p>2. Wave Distillery & Breweries Ltd. (Breweries unit), Vill. – Ahmadpura, Ramghat Road, Tehsil – Atrauli, Aligarh</p> <p>3. Wave Distilleries & Breweries Ltd., Vill- Ahmedpura, Ramghat Road, Tehsil – Atrauli, Distt. – Aligarh</p> <p>4. Heinz India Pvt. Ltd., Manzurgarhi, Anupshahar Road, Aligarh</p> <p>5. Ganga Dairy, Tulsipuram, Ramghat Road, Atrauli, Aligarh</p> <p>6. Kisan Sahkari Chini Mills Ltd, Satha, Aligarh</p>
8.	D/s Aligarh to D/s Kasganj	03	<p>GPIs in Catchment of Kali-East (Kasganj Region)</p> <p>1. Sterling Agro Food Industries Ltd., Kasganj</p> <p>GPIs in Catchment of Kali-East (Etah)</p> <p>1. Anik Industries Ltd. (Nutricia India Pvt. Ltd.), Dairy Complex, Kasganj Road, Etah</p> <p>2. Unilever India Export Ltd. (Instant Tea Unit), Kasganj Road, Etah</p>
Total number of GPIs		97	