

# **ACTION PLAN FOR REJUVENATION OF STRETCH OF RIVER PERIYAR-Always- Eloor to Kalamassery (Priority-V)**

DEPARTMENT OF IRRIGATION

KERALA WATER AUTHORITY

KOCHI CORPORTION

LOCAL SELF GOVERNMENT DEPARTMENT

INDUSTRIES DEPARTMENT

SUCHITWA MISSION

KERALA STATE REMOTE SENSING AND ENVIRONMENT CENTRE

DISTRICT ADMINISTRATION

**MAY 2019**

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## Executive Summary

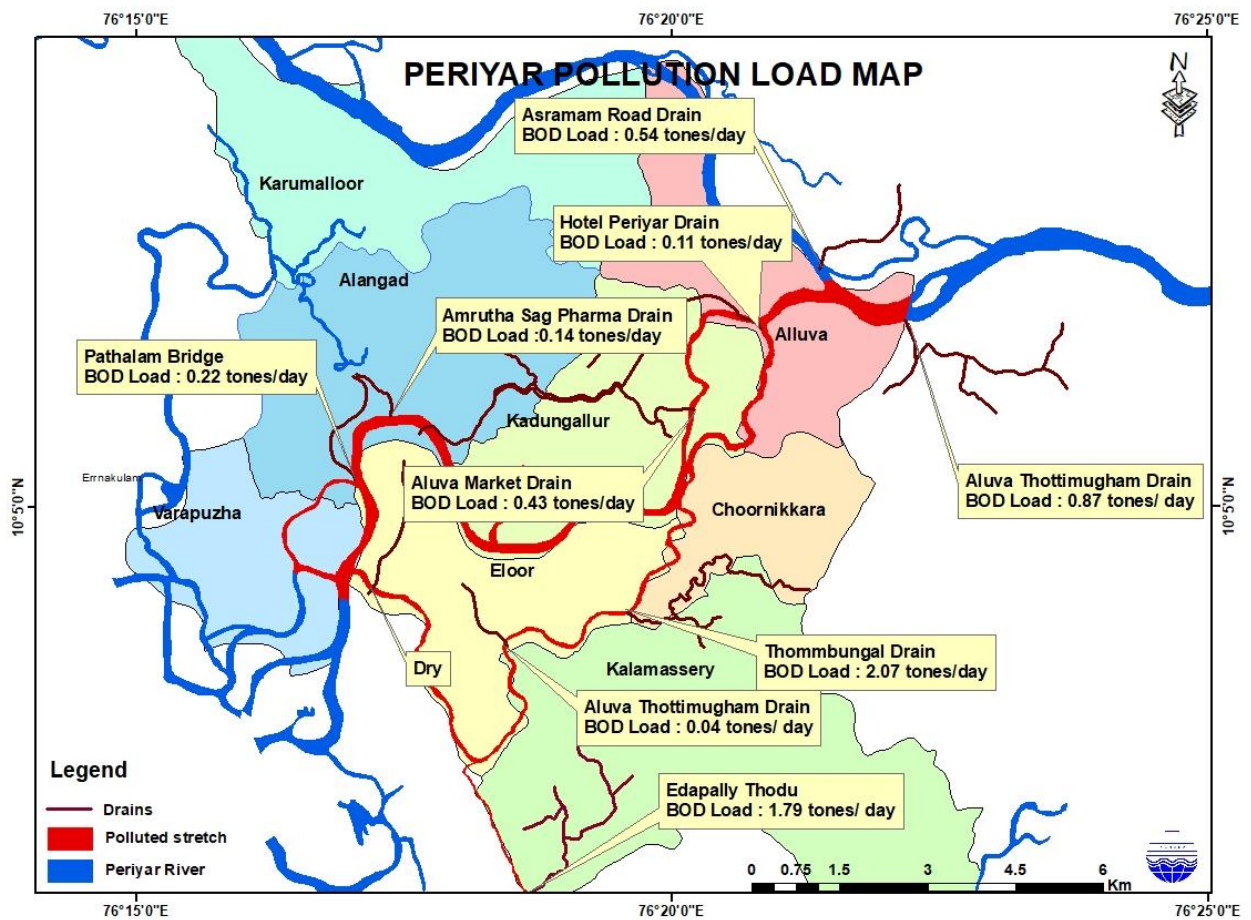
The draft action plan of Periyar River was submitted before Hon'ble NGT earlier on 15-12-2019. The modified action plan is given below.

The River Periyar, the longest river of the state (length of Periyar in Kerala is recorded as 244 km) originates from the Sivagiri peaks (1800m MSL) of Sundarmala in Tamil Nadu. Then it is joined by the Mullaiyar, 16 km downstream. It is joined by six tributaries of which the important tributary Edamula joins the Periyar. Passing Malayattur and thereafter taking a meandering course, the river reaches Alwaye where it divides itself into two branches. The river Periyar bifurcates at Alwaye into Mangalapuzha branch and Marthandam branch. Mangalapuzha branch flows through the North Paravur region of Ernakulam and reaches the Arabian Sea through Munambham. Marthandam branch again bifurcates and one branch flow through Eloor – Edayar industrial belt and the other branch flows through Kalamassery and Manjummel, known as Edamula branch. The Periyar basin spreads over an area of 5,398 square kilometer, most of it in central Kerala.

Ten drains were identified as joining this polluted stretch. The pollution load in terms of BOD was assessed. The map showing the drains and BOD load is given below.

Sl. No.	Location	Area of Flow (Sqm)	Discharge(L/Day)	BOD(mg/l)	BOD(Tonne/Day)	COD(mg/l)	COD(Tonne/Day)
1	Amrutha Sag Pharma, Eloor	0.2	1382400	100	0.138	320	0.442
2	Pathalam Bridge	0.075	617143	360	0.222	1120	0.691
3	Aluva Thoittumugham	0.6	5456842	160	0.873	480	2.619
4	Shanti Lotous	No discharge through Drain (Dry)					

5	Asramam Road	0.05	1944000	280	0.544	880	1.711
6	Aluva Market/Jewel River woods flat	0.10	1024000	420	0.430	1280	1.311
7	Hotel Periyar	0.03	315977	340	0.107	1040	0.329
8	Puthalam Kadavu Drain	0.04	348365	120	0.042	400	0.139
9	Thoombungal Thodu	1.00	6912000	300	2.074	960	6.636
10	Edapally Thodu	1.20	9953280	180	1.792	560	5.574



As per the order G.O(MS)No.12/2019/WRD dated 30.04.2019, District level Technical Committee has been formed and meetings and field visits were conducted. Action plan prepared by concerned departments is detailed below:

#### SHORT TERM MEASURES

Sl No	Ref para no:48 as per NGT Order no.673/2018 dated 20.09.2018	Activity	Implementing agency	Cost Rs.	Source of fund	Time line	Expected outcome
1	A(b)	Augmentation and Revamping of existing STP at near Adwaitha Ashramam and to increase the capacity of STP so as to treat more sewage generated in the municipality	Aluva Municipality	6 Lakhs	Source of fund to be reported by Aluva Municipality	Dec 2019	Reduces the pollution load at Periyar River
2	A(b)	Augmentation and Revamping of existing STP at Aluva Market and to increase the capacity of STP so as to treat more sewage generated in the municipality	Aluva Municipality	15 Lakhs	Plan	2021	Reduces the pollution load at Periyar River
3	A(b)	Discharge of sewage from township to the River through drain near Periyar Hotel shall be stopped.	Aluva Municipality	5 Lakhs	Source of fund to be reported by Aluva Municipality	2020	To prevent the sewage discharging to drains
4	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain and to collect fine based on polluter pay principle	Aluva Municipality KSPCB	2 Lakh	Source of fund to be reported by Aluva Municipality	2020	Survey need to be conducted and action shall be initiated
5	A(a)(iv)	Periodical inspection in the	KSPCB	2 lakhs	Own fund	Periodic	The STP/ETP

		Industries, Flats, hotels monitoring of STP,ETP.				al	shall be monitored to assess the efficiency
6	C(ii)	Installation of modern abattoirs.	Aluva Municipality	2 Cr	Plan	March 2021	The unauthorized slaughtering with proper waste disposal system can be controlled.
7	A(b)	Procurement of sewer cleaning machines and equipment maintenance	Aluva Municipality	40 Lakhs	Plan	March 2020	The sewers shall be cleaned and maintained properly inorder to avoid block, mosquito breeding etc
8	E	Installation of cameras at the waste dumping spots	Aluva Municipality	5 lakhs	plan	2020	The waste dumping practices can be minimized.
9	A(b)	Construction of retaining wall with HDPE liner at Kalamassery dumping yard in order to prevent the leachate discharge from the yard to Thoombungal Thodu	Kalamassery Municipality	1.40 Cr	Plan	Sept 2019	Reduces the pollution load at Thoombungal thodu. Prevent leaching from dumping yard to thoombungal thodu. Construction work of retaining

							wall progressing
10	C(ii)	Installation of plastic shredding unit	Kalamassery Municipality	1 Cr	Plan	June 2019	
11	A(a)(iv)	Constitution of squads for night surveillance for finding the unauthorized dumping of sewage at NAD wet lands Kalamassery	Kalamassery Municipality Police department	1 Lakhs	Plan	2020	Prevents unauthorized dumping of septage which reaches the thombungal thodu
12	A(b)	Installation of common STP for Kalamassery Municipality and ETP at Municipal Market	Kalamassery Municipality	25 Lakhs	Plan	December 2019	Stops the discharge to the drain which joins at Puthalamkadavu
13	A(a)(iv)	Monitoring and surveillance of industries in Kalamassery Industrial Estate in order to prevent unauthorized discharges to Muttar River	KSPCB	5 Lakhs Own fund	Plan	2019	Unauthorized discharges can be controlled.
14	C(ii)	Installation of modern abattoirs including poultry and meat rendering plants.	Kalamassery Municipality  Industries Department (for land allotment)	30 Lakhs	Plan	2021	The unauthorized slaughtering with proper waste disposal system can be controlled. Land may be allotted from KINFRA or From HMT
15	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the	Kalamassery Municipality	2 Lakhs	Own fund	2020	Detailed Survey to be conducted

		sewage to the public drain.					
16	E	Installation of cameras at the waste dumping spots	Kalamassery Municipality	5 lakhs	Own fund	2020	The waste dumping practices can be minimized.
17	A(b)	Identification of sources of sewage discharged to drain near Pathalam bridge and action to stop the discharge which reach river Periyar from hotels, labour camps etc In case the quantity of sewage generated is assessed to be more STP need to be installed	Eloor Municipality KSPCB (for monitoring)	2 Lakhs for study 15 Lkabs for STP	Own fund	2020	Detailed Survey to be conducted
18	E	Installation of cameras at the waste dumping spots	Eloor Municipality	5 lakhs	Own fund	2020	The waste dumping practices can be minimized.
19	A(a)(iv)	Periodical inspection in the Industries, Flats, hotels for monitoring of STP,ETP located in Cochin corporation.	KSPCB	1 Lakh	Own fund	In progress	To assess the efficiency of STP and to prevent unauthorized discharge
20	A(a)	Inventory of sources of pollution through a rapid study/Study for identification of pollution sources at Edapally thodu	Cochin Municipal Corporation	3 Lakh	Plan fund	3 months	Can Identify the sources of sewage discharged to thodu ultimately reaching at River Periyar at downstream of Manjummal bund
21	E	issuing notice to the	Cochin	-	Own fund	4	To warn the



		defaulters	Municipal Corporation			months	defaulters and to direct them to make alternative arrangements for disposal of the waste including construction of treatment plants.
22	A(a)(iv)	Periodical inspection in the flats, hotels, shops located along the river	Cochin Municipal Corporation	-	Own fund	Periodical	Prevent illegal dumping and unauthorized discharges
23	A(b)	Identification of natural drains/thodu reaching river Periyar and cleaning of weeds, grasses etc	Irrigation department	5 Cr	plan fund	2 years	River flow can be maintained and also prevent encroachment.
24	C(iii)	Clearing of weeds, grasses at the river bank in order to ensure the smooth flow of water	Irrigation department	2 Cr	plan fund	3 years	River flow can be maintained and also encroachments can be prevented
25	D(a)	Maintaining of Minimum flow in river during lean period and periodical operation of Regulators at River in-order to maintain minimum flow.	Irrigation department	25 Lakhs	plan fund	3 years	To avoid stagnation of water and prevents algal bloom and fish death
26	A(b)	Common Effluent Treatment Plant at Edayar Industrial	Industries department	3 Cr	Plan	2022	All small scale

		Estate					industries can treat their effluent in common ETP and in turn helps in water pollution control. The existing proposal for the CETP of industries department was withdrawn due to public protest.
27	A(b)	Construction of internal roads and proper drainage in Edayar industrial estate	Industries department	5 Cr	Plan	Work progressing	No proper storm water drains provided in the industrial belt. Proper drainage helps to segregate the storm water and prevent stagnation and water logging
28	A(b)	Installation of common discharge pipe line at downstream of Pathalam Regulator Bridge	Industries department Irrigation department	3.0Cr 50 lakhs	plan fund	3 Years	Discharge of all industrial treated effluent at downstream of pathalam regulator

							Bridge (estuary) helps to improve the water quality at upstream area.
29	E	Installation of Night vision surveillance cameras at the River Bank side	KSPCB	2Cr	Plan Fund	2020	At present 9 cameras already installed by PCB at River side. Installation of more cameras helps ineffective surveillance of industries
30	A(a)(iv)	Periodical Monitoring of Eloor, Edayar, Kalamassery Industrial belts	KSPCB	5 lakhs (purchase of portable water analyzers , Boat)	Plan Fund	2020	Control water pollution due to industrial discharge
31	A(a)(iv)	Monitoring of quality of water at various intake point	Kerala Water Authority	2 Lakhs(purchase of water analyzers )	Own fund	2020	Ensure the quality of treated water supplied to the communities
32	A(a)(iv)	Installation of additional continuous online River water monitoring station	KSPCB	2 Cr	Plan Fund	2022	At present one station installed at downstream of Periyar. Additional facility can

							be provided. Helps to monitor the river water quality. Data will be connected to the server and can be shared in public domain.
33	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain	Kadungallur Panchayath	2 Lakhs	Plan	2020	Detailed Survey to be conducted
34	E	Installation of cameras at the waste dumping spots	Kadungallur Panchayath	5 lakhs	Own fund	2020	The waste dumping practices can be minimized.
35	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain	Choornikkara Panchayath	2 Lakhs	Plan	2020	Detailed Survey to be conducted
36	E	Installation of cameras at the waste dumping spots	Choornikkara Panchayath	5 lakhs	Plan	2020	The waste dumping practices can be minimized.

**LONG TERM MEASURES**

Sl No	Ref para no:48 as per NGT Order no.673/2018 dated 20.09.2018	Activity	Implementing agency	Cost Rs. Cr	Source of fund	Time line	Expected outcome
1	A(b)	Construction of walkway, ring roads etc at the Periyar River bank at industrial belt.	Irrigation department	20 Cr	plan fund	4 years	Helps in monitoring of industries and can easily find any un authorized discharge from industries
2	C(i)	Fencing of the river banks along the stretches of waste disposal (Edamula stretch)	Cochin Municipal Corporation	1 Lakh	Plan fund	1-2 years	Throwing of waste materials into the river bodies can be prevented by this
3	C(iii)	Beautification of the river stretches (Edamula stretch)	Cochin Municipal Corporation	1 Lakh	CSR funds	1-2 years	Improve aesthetic appearance

**ACTION PLAN BY GROUND WATER DEPARTMENT**

Sl.No	Ref para no:48 as per NGT Order no.673/2018 dated 20.09.2018	Activity	Ground Water Department
1	B(i)	Ground Water resources and regulation of ground water extraction by industries particularly in over exploited as critical zones/blocks	As per Groundwater resources of Kerala, 2017 estimate a total number of 4 blocks (Alangad, Paravoor, Parakkadavu, and Vypin) comes under the Periyar river basin. All the blocks in the river stretch except Parakkadavu block are safe with stage of groundwater extraction ranges from 46.26% to 79.12%
2	B(ii)	Ground water recharging / rain water harvesting	The average pre-monsoon groundwater level of the blocks ranges from 1.465 - 4.43 mbgl. Since the area falls in the coastal sedimentary belt, groundwater recharge is not possible.
3	B(iii)	Periodic ground waste quality assessment and remedial actions in case of contaminated ground water tube wells/bore wells or hand pumps	Groundwater Department has 2 observation dug wells in this river stretch.
4	B(iv)	For regulating use of ground water for irrigation purpose, adopting good irrigation practices	The total irrigation draft in the area ranges from 53.64 - 1008 ha.m.

## **CHAPTER I- INTRODUCTION**

### **1.1 Periyar River**

The River Periyar, the longest river of the state (length of Periyar in Kerala is recorded as 244 km) is considered to be the life line of Central Kerala. It originates from the Sivagiri peaks (1800m MSL) of Sundarmala in Tamil Nadu 80 km south of Devikulam at an elevation of 2,438m above MSL and traverses the steep mountainous terrain before it is joined by the Mullaiyar, 16 km downstream. The river then turns west and continues to flow in the direction for about 16 km in sandy bed. After a course of about 13 km, the river reached Vandiperiyar and passes through a second narrow valley below which the Perumthura joins it. Further down, it is joined by six tributaries of which the important tributary Idamalayar joins the Periyar. Passing Malayattur and thereafter taking a meandering course, the river reaches Alwaye where it divides itself into two branches. The river Periyar bifurcates at Alwaye into Mangalapuzha branch and Marthandam branch. Mangalapuzha branch flows through the North Paravur region of Ernakulam and reaches the Arabian Sea through Munambham. Marthandam branch again bifurcates and one branch flow through Eloor – Edayar industrial belt and the other branch flows through Kalamassery and Manjummel, known as Edamula branch. Periyar plays a major role in power generation, domestic water supply, irrigation, tourism, industrial production, collection of various inorganic resources and fisheries along with a variety of shell fishes which includes crabs, prawns and so on.

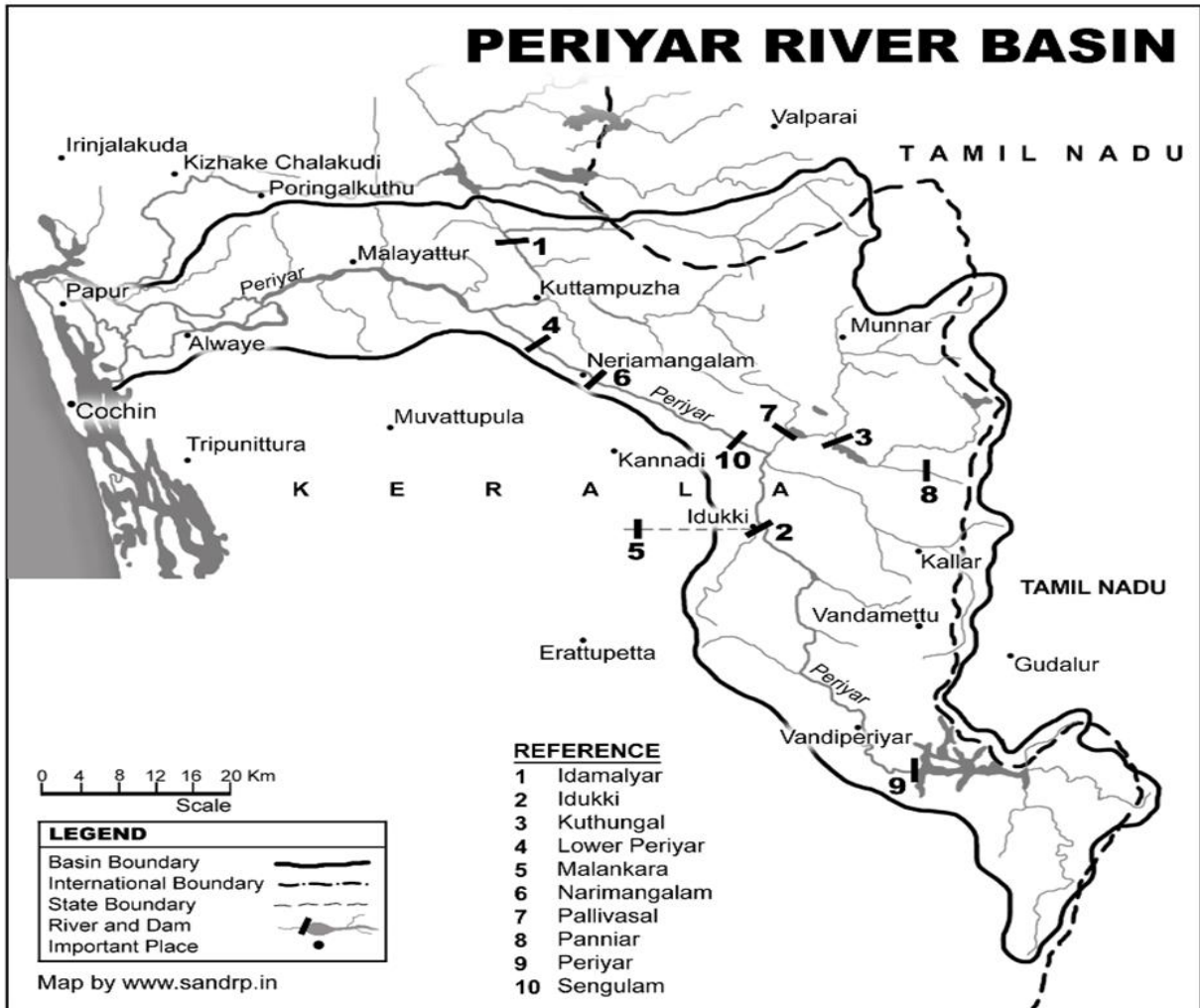


Figure 1.1 Catchment area of Periyar River Basin

The Periyar basin spreads over an area of 5,398 square kilometers (2,084 sq mi), most of it in central Kerala. Forests occupy nearly 1,500 square kilometers (580 sq mi) (28%) of the basin area whereas cardamom and settlement with mixed tree crops occupy an area of 322 square kilometers (124 sq mi) and 2,176 square kilometers (840 sq mi) respectively. The basin is ecologically sensitive. Nearly 80% of the total areas situated in the high ranges are susceptible to erosion and mass movements. The Idukki dam is the largest hydro-electric project in Kerala and lies on the Periyar. It is the biggest dam of its kind (a concrete, double curvature parabolic, thin arch dam) in Asia and the second-biggest in the world. Its generators have a power output of 780 MW ( $6 \times 130$ ), and generate electricity through the underground facility at Moolamattam, built by an India-Canada joint venture. Power generation at Idukki is minimal during the monsoon. The dam also permits storage of



water for the dry summer period when many other reservoirs in the area are low. There are a number of reservoirs in the river basin and they are Bhoothathankettu, Idukki, Lower Periyar, Kallarkutty, Ponmudy, Mullaperiyar, Mattupetty, Aanairangal, Kundala and Idamalayar. It has a catchment area of 5284 Km<sup>2</sup> in Kerala.

### **1.2 Topography**

About 35% of the area of Periyar basin is forests. But some of these areas have already been cleared for various developmental activities. In the highland region, the major human activities are connected with plantation, hydroelectric projects and new settlements and building activities in the Idukki district. While the plantation in the very high reaches such as Udumpenchola, Peerumedu and Devikulam are cardamom, tea and pepper, the foothills are cultivated with rubber, coconut and pepper. The midland belt has mainly paddy, coconut and plantains. The irrigation projects of the basin are intended to cater to the requirements of mainly the midland crops. The waste lands cover only 5-8% of the total basin area. These are situated in the highest peaks or the coastal saline belts in the low land. The major industries and settlements are in the lower reaches, especially in the Alwaye, Ernakulam belt. There are a number of islands in the lower reaches of the basin .The major classification of forests in the basin is wet-evergreen, semi-evergreen, moist-deciduous, dry-deciduous and pure reed areas.

### **1.3 Ecological significance**

South of the Mullaperiyar reservoir, at the source of Periyar River, there is an unbroken stretch of about 350 square kilometers (140 sq mi) of sheltered, unmodified rainforests within the Periyar Tiger Reserve. These rainforests extend further west into the adjacent Pamba basin within the Gudarakal Forest Range and continue south beyond the Gudarakal Range into the forests of the Achankovil Division. This entire stretch contains about 600 to 700 square kilometres (230 to 270 sq mi) of undisturbed wet evergreen forests typical of the Western Ghats. The Periyar Tiger Reserve (PTR) is also one of the most ecologically diverse regions in India. The flora of the reserve is very rich and diverse. Out of the estimated 3,800 species of angiosperms of Kerala, 1,966 have been reported from within the reserve.

#### **1.4 Religious and Cultural significance**

There are several places of religious significance along the banks of the Periyar. The famous Aluva Sivarathri festival is celebrated on the banks of the Periyar River in Aluva. Kalady is a town located on the banks of the Periyar river. It is the birthplace of Sri Adi Shankara, the Hindu philosopher who consolidated the doctrine of Advaita Vedanta. Located 52 kilometres from Kochi, the Malayattoor Church is situated atop the 609-metre (1,998 ft) high Malayattoor Hill. The church is dedicated to St. Thomas, who is believed to have prayed at this shrine. One of the most important Christian pilgrim centres in Kerala. The town of Kodungallur lying close to the Periyar river is famous for the Cheraman Juma Masjid. The tradition holds that the mosque, built in 629 AD by Mālik bin Dīnār, is the oldest mosque in India and the second oldest mosque in the world to offer Jumu'ah prayers

#### **1.5 Industrial Area**

Twenty five percent of the industries of the state are located along the banks of Rive Periyar and the concentration of these industries is within a stretch of 5 km in the Eloor – Edayar area, which is only 10 km north of Cochin Port. These industrial complexes depend on the river for intake of process water and disposal of effluents. The river also provides water for irrigation and domestic use all along its course, besides supporting a rich fishery. The Cochin Corporation, in the vicinity of river mouth has an intake point upstream of Aluva to meet its water supply: this point is generally free from salinity intrusion. A Regulator cum bridge is constructed near Manjaly bridge (known as Purappallykkavu bund) in order to prevent saline water intrusion during post monsoon season and a Regulator cum bridge (Pathalam bund) is also constructed at Pathalam in the downstream of Pathalam bridge. In the Edamula branch a permanent regulator is in operation at Manjummel. This bund/regulator prevents the entry of saline water during high tide to the upstream of the river. All major industries in Eloor area are located downstream of the bund and some industries are located in the upstream of bund but just downstream of the Pathalam bridge.

Angamaly to Kochi come under the most industrialized zone of the Periyar river basin. There are over 50 large and medium industries and over 2500 small scale industries are located in this region. There are 83 red category industries are located in Greater Kochi area. Out of that 79 industries (95% of the total) fall within the industrial clusters at Eloor-Edayar and Ambalamugal which together constitute 17.4 km<sup>2</sup> or 2.8% of Greater Kochi Area. Because Eloor and Edayar are situated on the left and right banks of river Periyar, Eloor –

Edayar area is considered together. Ambalamughal is area wise bigger than Eloor-Edayar but the major part of the area is occupied by just four large scale industries.

### **1.6 SOURCES OF POLLUTION**

Generally, the pollutants come from three prominent sources-

- (i) Sewage discharged into the river,
- (ii) Industrial effluents discharged into the river without any pretreatment.
- (iii) Surface run off from agricultural land, where chemical fertilizers, pesticides, insecticides and manures are used.

This makes the river water unsafe for drinking and bathing.

### **1.7 DESIGNATED BEST USE CLASSIFICATION OF STREAMS**

The Central Board classified the inland surface waters into five categories (A to E) on the basis of designated-best-use. The principal concern here is the end use to which the water may be put to by man. The classification has been made in such a way that the water quality requirement becomes progressively lower from A to E. Besides, the water quality of any one of the five categories also satisfies the requirements of categories lower than the chosen one. An area or stretch of a body may be subjected to a number of uses. The area or the stretch is designated by that particular use which demands the highest/purest quality is the best possible way the Designated-best-use can be defined.

**TABLE 1.1**

<b>Designated Best Use</b>	<b>Class of Water</b>	<b>Criteria</b>
Drinking Water source without conventional treatment but after disinfection	A	1. Total coliform organisms MPN/100 ml shall be 50 or less. Note : If MPN count is noticed to be more than fifty then regular Tests should be carried out. The criteria would be satisfied if during a period of time not 1 more than 5% of the samples show greater than 200 MPN/ 100 ml and not more than 20% of samples show more than 50 MPN/ 100 ml. 2. pH: between 6.5 and 8.5 3. Dissolved Oxygen 6 mg/l or more. 4. Biochemical Oxygen Demand (5-day at 200C):2 mg/l or less. Note : There shall be no visible discharge of domestic and industrial wastes into class A.
Outdoor bathing, (Organized)	B	1. Total coliform organisms (MPN/100 ml shall be 500 or less. Note : If MPN count is noticed to be more than 500 MPN/100 ml then regular tests should be carried

		<p>out. The criteria would be satisfied if during a period of time not more than 5% of the samples show greater than 2000 MPN/100 ml and not more than 20% of samples show greater than 500 MPN/100 ml</p> <p>2. pH: between 6.5 and 8.5</p> <p>3. Dissolved Oxygen: 5 mg/l or more.</p> <p>4. Biochemical Oxygen Demand (5-day at 200C):3 mg/l or less.</p> <p>5. Note : All domestic and industrial wastewater discharge upstream of bathing places shall be so regulated that the stream standards are maintained and that there is no visible floating matter including oils at the bathing places</p>
Drinking water source	C	<p>1. Total coliform organisms (MPN/100 ml shall be 5000 or less. Note : If MPN count is noticed to be more than 5000 MPN/100 ml then regular tests should be carried out. The criteria would be satisfied if during a period of time not more than 5% of the samples show greater than 20,000 MPN/100 ml and not more than 20% of samples show greater than 5000 MPN/100 ml</p> <p>2. pH: between 6 and 9</p> <p>3. Dissolved Oxygen: 4 mg/l or more.</p> <p>4. Biochemical Oxygen Demand (5-day at 200C):3 mg/l or less.</p> <p>5. Note : All domestic and industrial wastewater discharge into Class C waters shall necessarily be treated to ensure maintenance of stream standards are and the discharge points shall be kept sufficiently away</p>
Propagation of wild life, fisheries	D	<p>1. pH: between 6.5 and 8.5</p> <p>2. Dissolved oxygen: 4mg/l or more.</p> <p>3. Free Ammonia (as N): 1.2 mg/l or less</p>
Irrigation, industrial cooling and controlled waste	E	<p>1. pH: between 6.0 to 8.5</p> <p>2. Electrical conductivity at 200C/mho/cm:Max 2250</p> <p>3. Sodium Absorption Ratio : Max 26.</p> <p>4. Boron : Max 2 mg/l.</p>

## CHAPTER II

### 2.1 AREA OF STUDY

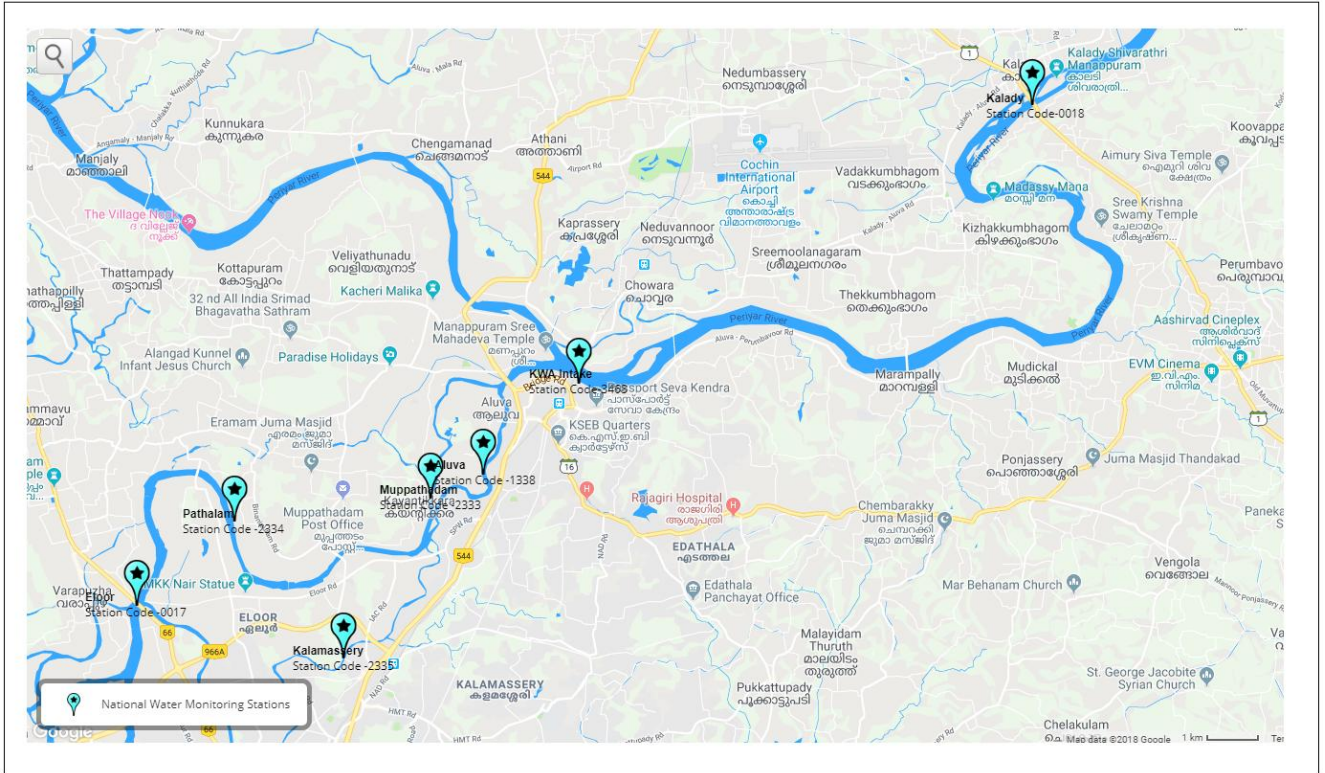
The study area includes Idukki to Eloor. Samples were collected from Panamkutty bridge, Neriya Mangalam, Marampilly, Aluva Manappuram, Kalamassery thoombungal thodu. Kerala Pollution Control Board, Central Lab at Ernakulam is taking monthly samples from different location of Periyar River under National Water Monitoring Programme (NWMP) in order to assess the quality of River. Board office at Eloor is also conducting monitoring in River Periyar in Eloor- Edayar stretch. Daily samples are taken from 4 stations and also monthly river sampling done at industries effluent discharge points. All these data are considered in the preparation of action plan. Above that other river stations were identified for the study and samples were taken for 3-4 days.

### 2.2 DETAILS OF SAMPLING POINTS

#### 2.2 (a) Stations under National Water Monitoring Programme (NWMP)

**TABLE 2.1**

<b>SI No</b>	<b>NAME OF LOCATION</b>	<b>FREQUENCY</b>
1	Periyar Near Aluva- Eloor	MONTHLY
2	Periyar At Kalady	MONTHLY
3	Periyar At Sewage Discharge Point Aluva	MONTHLY
4	Periyar At Muppathadam	MONTHLY
5	Periyar At Pathalam(Vettukadavu)	MONTHLY
6	Periyar At Kalamassery	MONTHLY
7	Periyar at KWA intake, Aluva, Ernakulam	MONTHLY



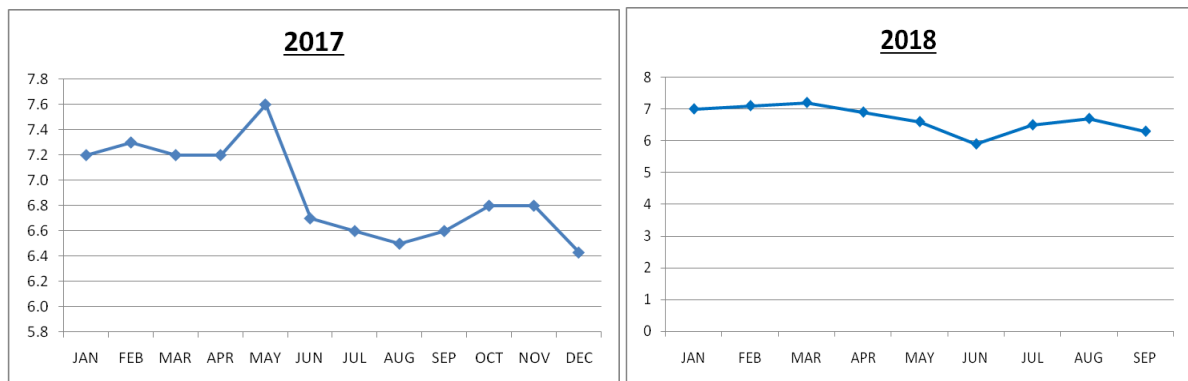
(figure 2.1 Map of NWMP stations)

**MAP OF NWMP STATIONS**

**ANALYSIS REPORT OF NWMP STATIONS**

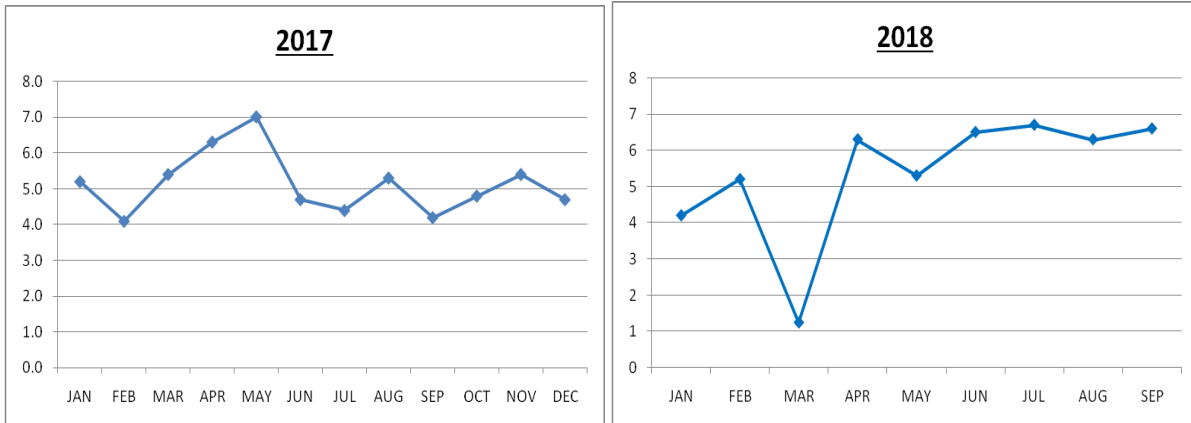
**PERIYAR RIVER NEAR ALUVA-ELOOR**

**PARAMETER : PH**



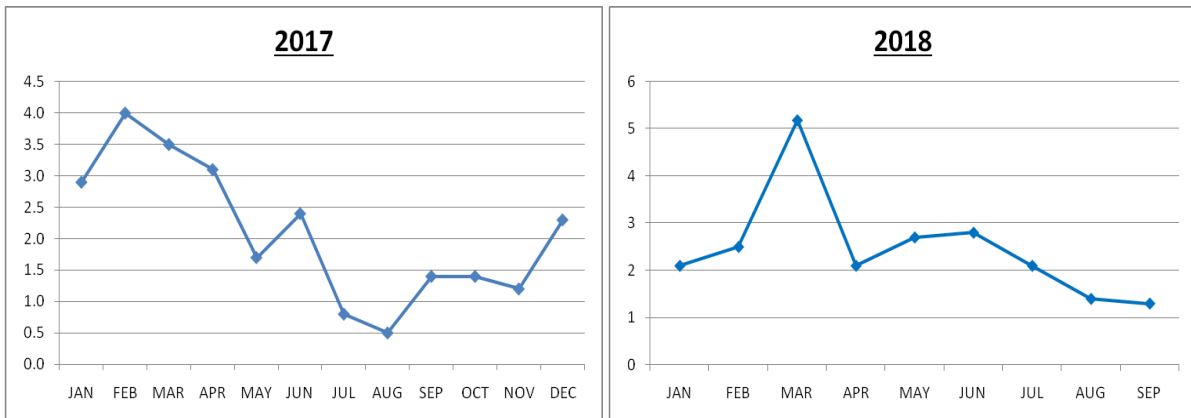
(figure 2.2 trend of the parameter pH)

**PARAMETER : D.O (mg/l)**



**(figure 2.3 trend of the parameter D.O)**

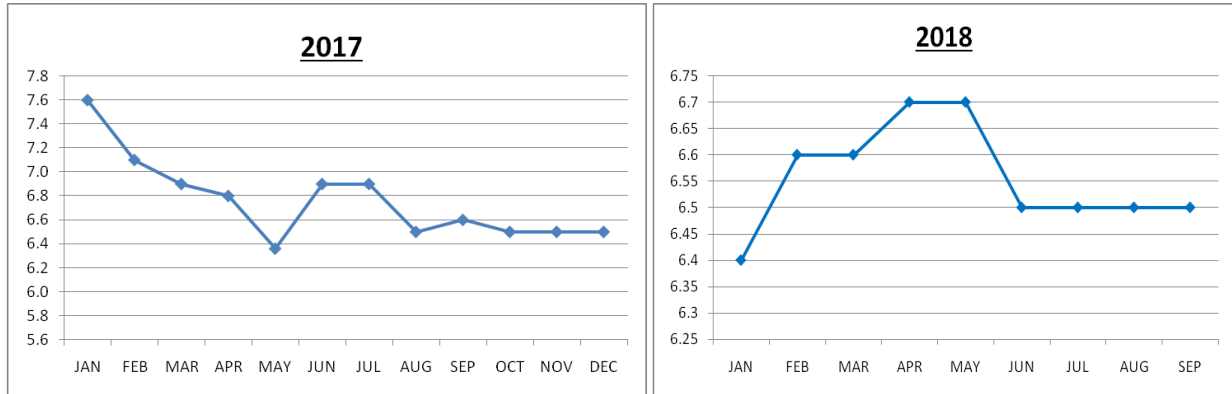
**PARAMETER : B.O.D**



**(figure 2.4 trend of the parameter B.O.D)**

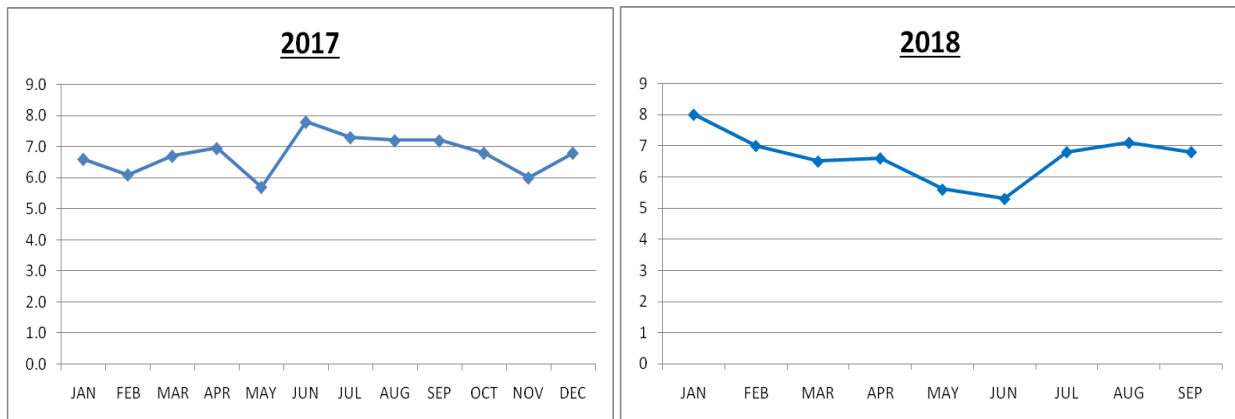
# PERIYAR AT KALADY

## PARAMETER: pH



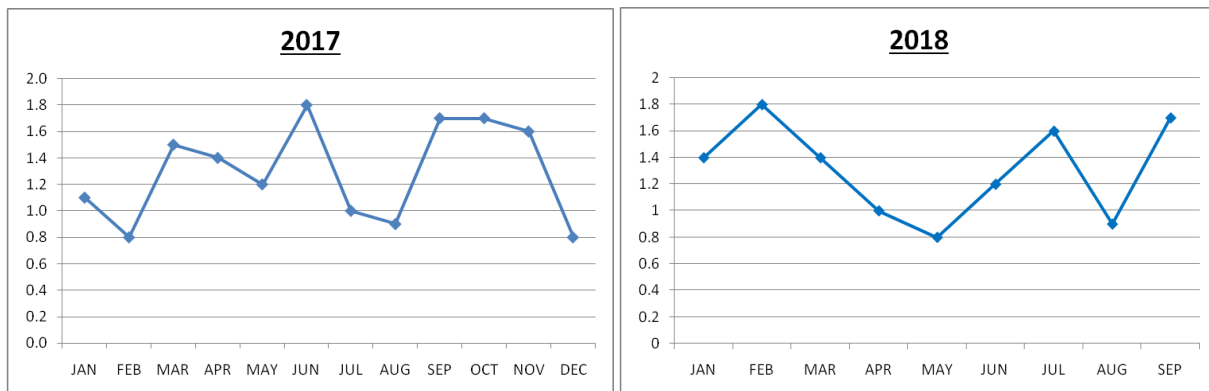
(figure 2.5 trend of the parameter pH)

## PARAMETER : D.O (mg/l)



(figure 2.6 trend of the parameter D.O)

## PARAMETER : B.O.D

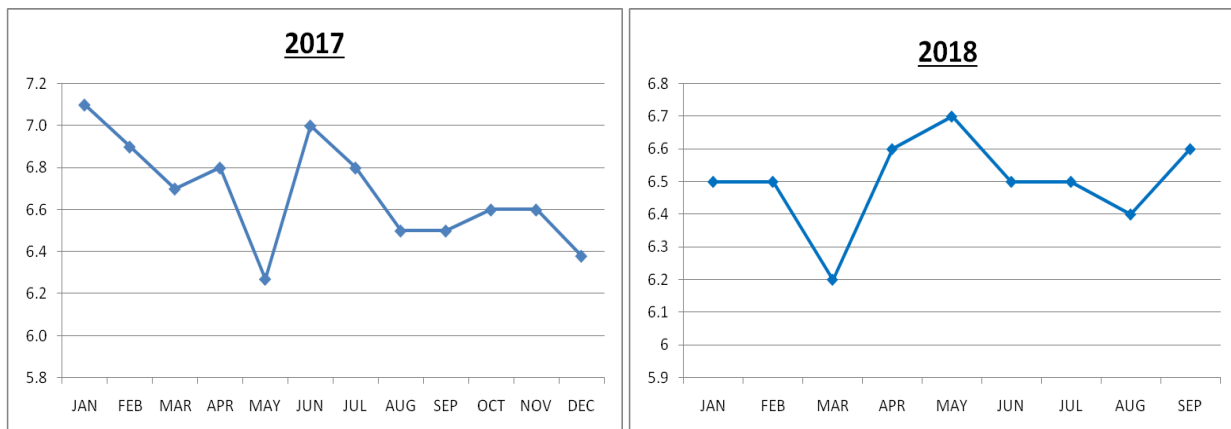


(figure 2.7 trend of the parameter B.O.D)



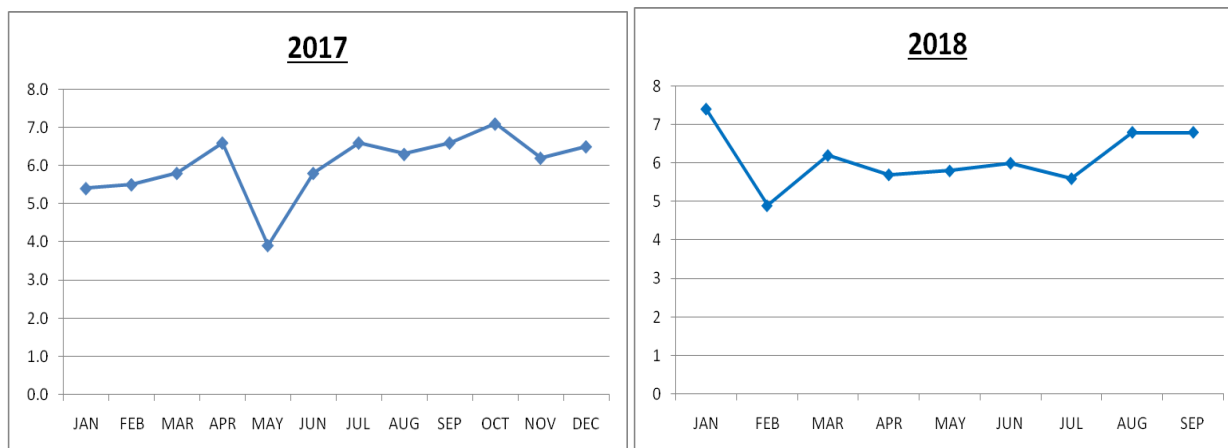
## PERIYAR AT SDP ALUVA

### PARAMETER : pH



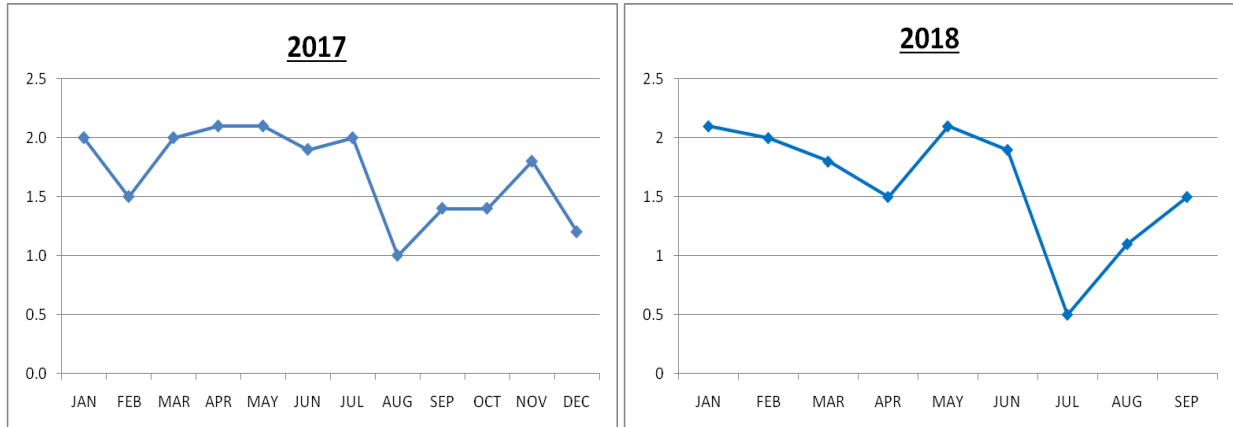
(figure 2.8 trend of the parameter pH)

### PARAMETER : D.O (mg/l)



(figure 2.9 trend of the parameter D.O)

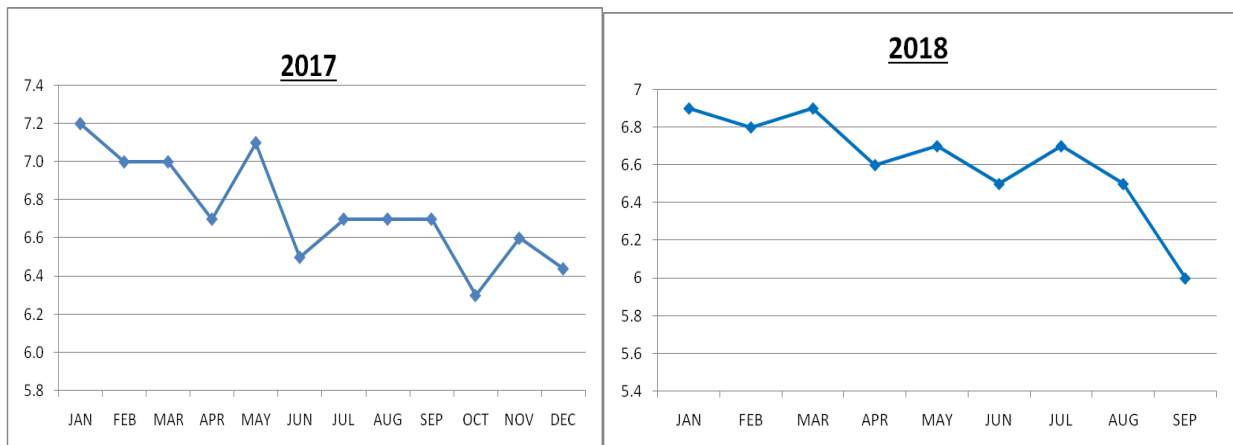
**PARAMETER : B.O.D**



(figure 2.10 trend of the parameter B.O.D)

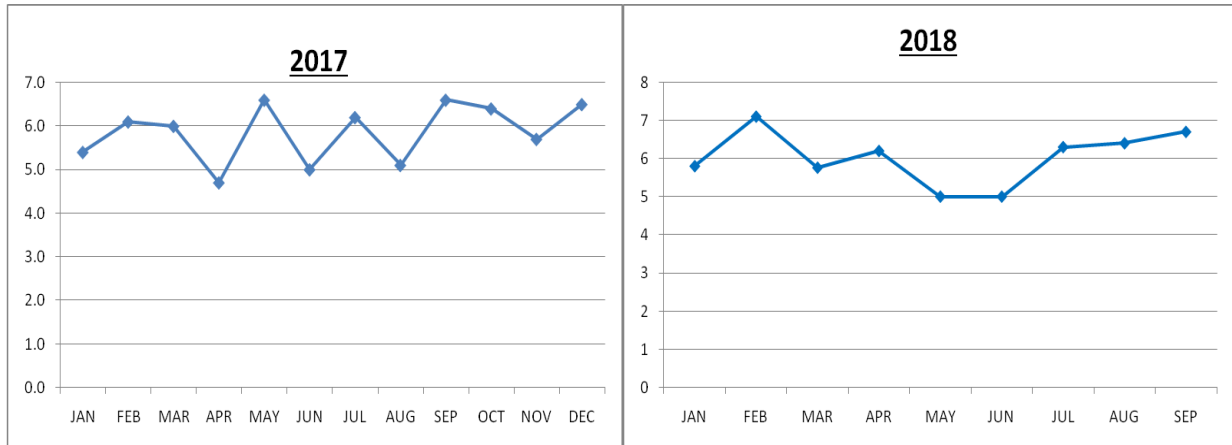
**PERIYAR AT MUPPATHADAM**

**PARAMETER : PH**



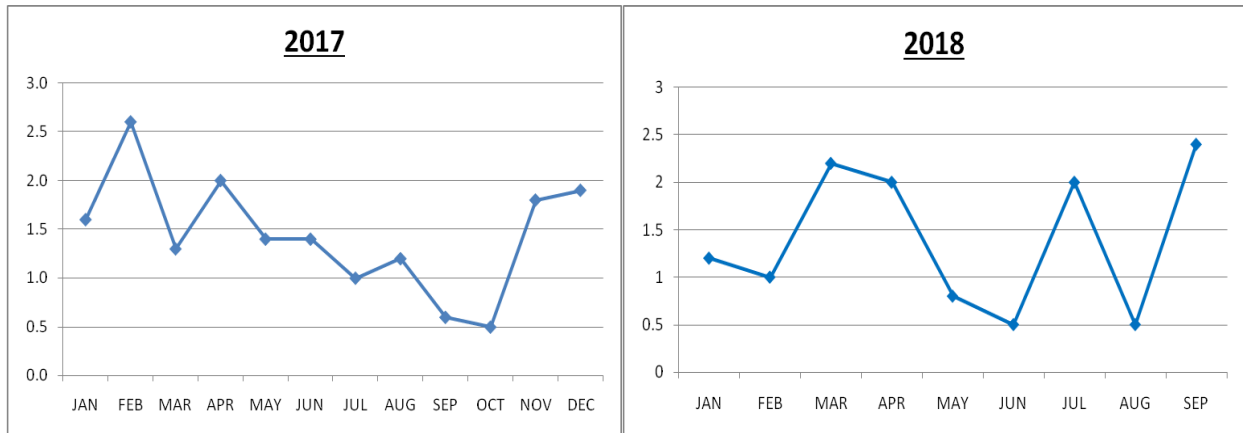
(figure 2.11 trend of the parameter pH)

**PARAMETER : D.O (mg/l)**



**(figure 2.12 trend of the parameter D.O)**

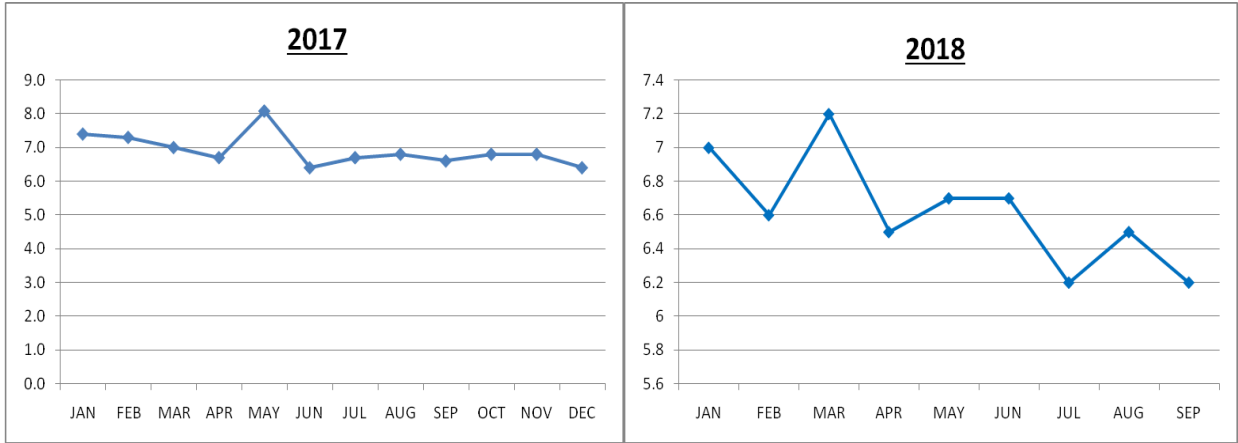
**PARAMETER : B.O.D**



**(figure 2.13 trend of the parameter B.O.D)**

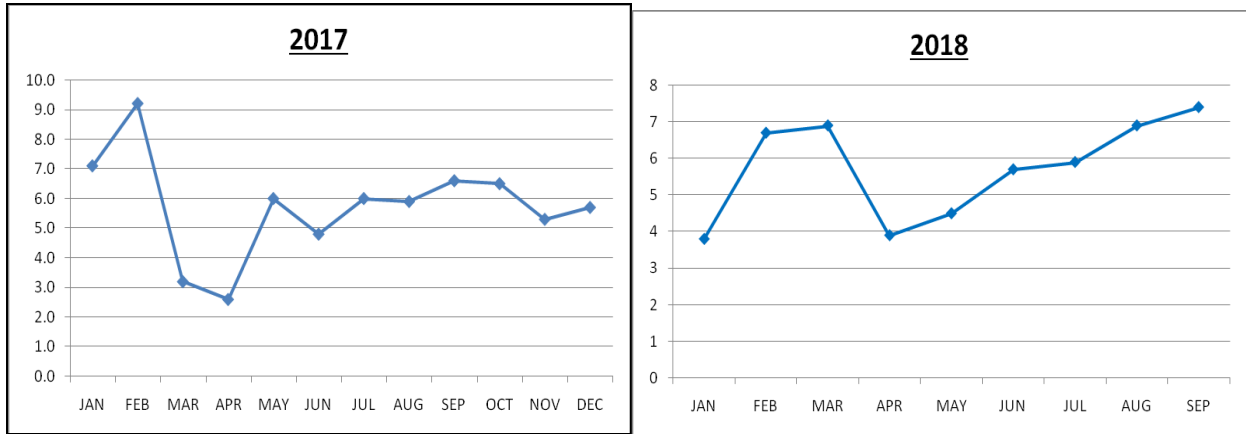
# PERIYAR AT PATHALAM (VETTUKADAVU)

## PARAMETER : PH



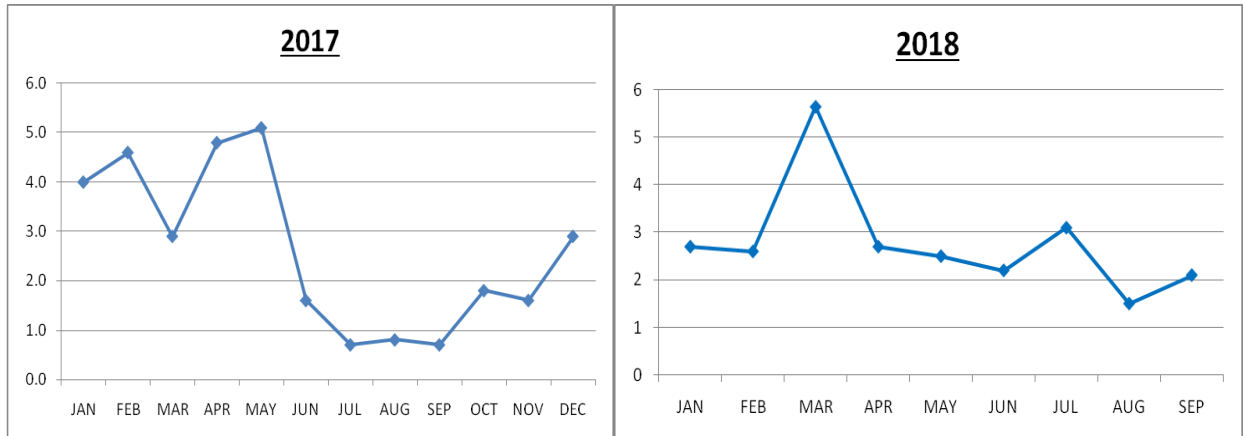
(figure 2.14 trend of the parameter pH)

## PARAMETER : D.O (mg/l)



(figure 2.15 trend of the parameter D.O)

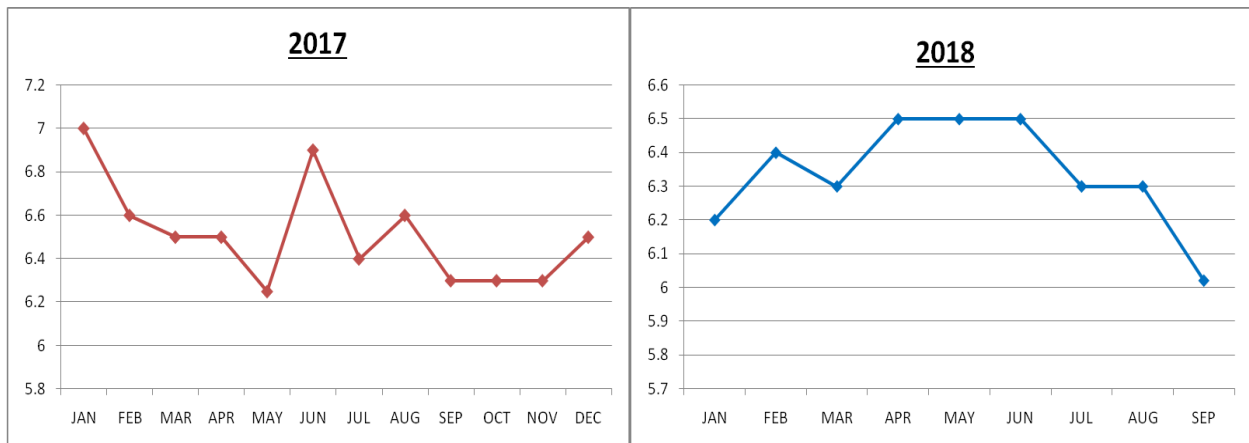
**PARAMETER : B.O.D**



(figure 2.16 trend of the parameter B.O.D)

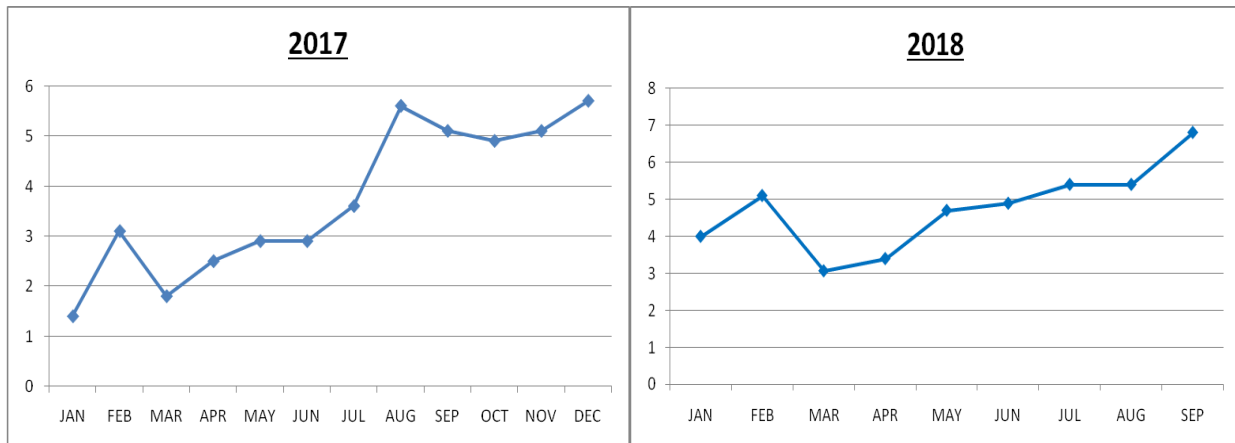
**PERIYAR AT KALAMASSERY**

**PARAMETER : pH**



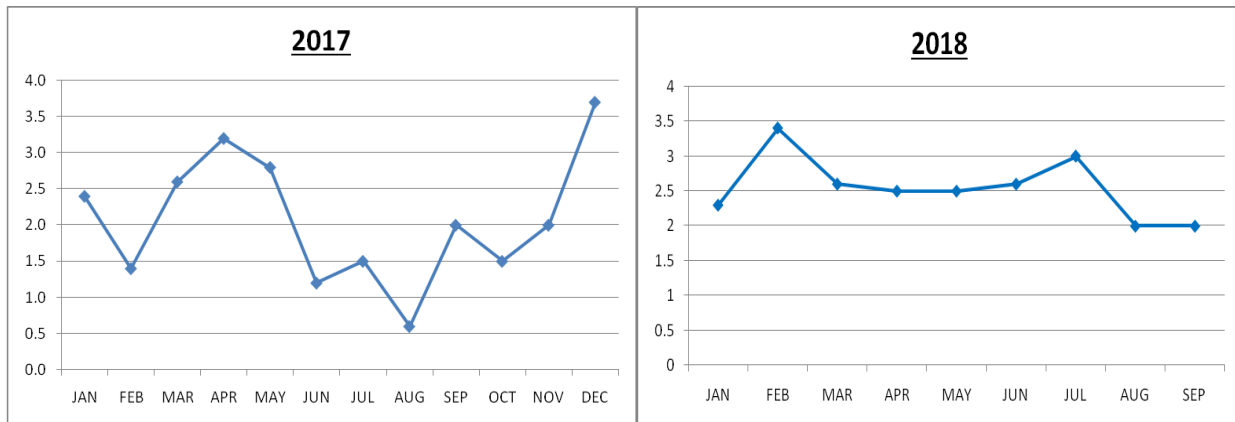
(figure 2.17 trend of the parameter pH)

**PARAMETER : D.O (mg/l)**



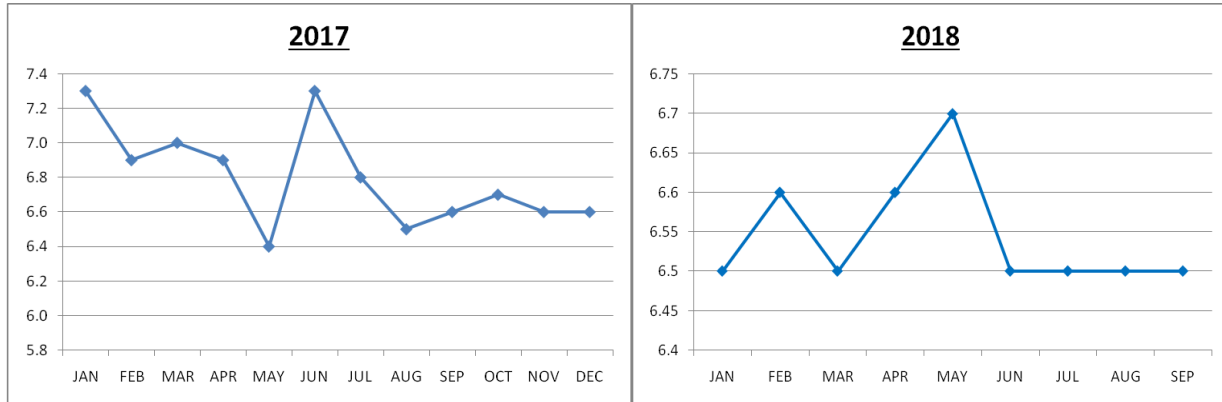
**(figure 2.18 trend of the parameter D.O)**

**PARAMETER : B.O.D**



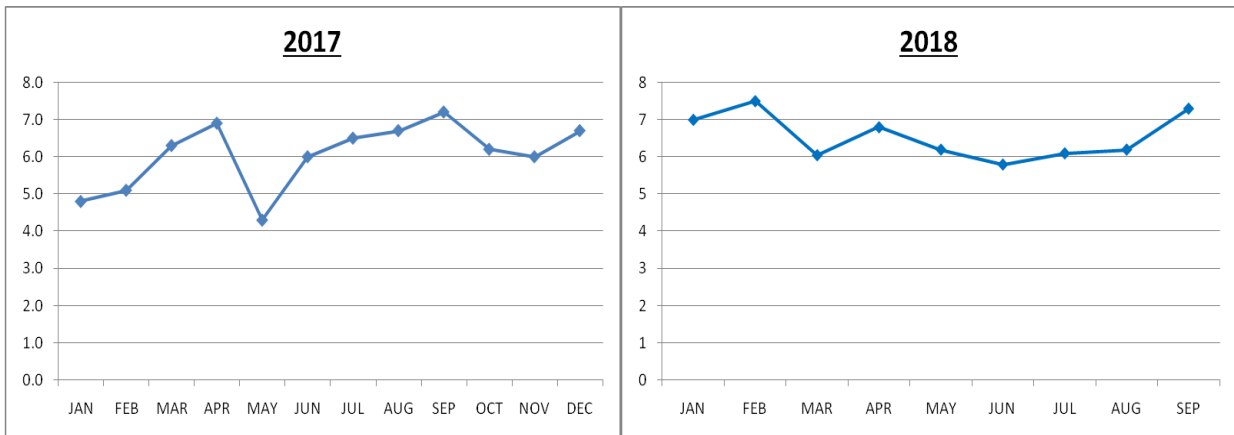
**(figure 2.19 trend of the parameter B.O.D)**

**PERIYAR AT KWA INTAKE, ALUVA, ERNAKULAM**  
**PARAMETER : PH**



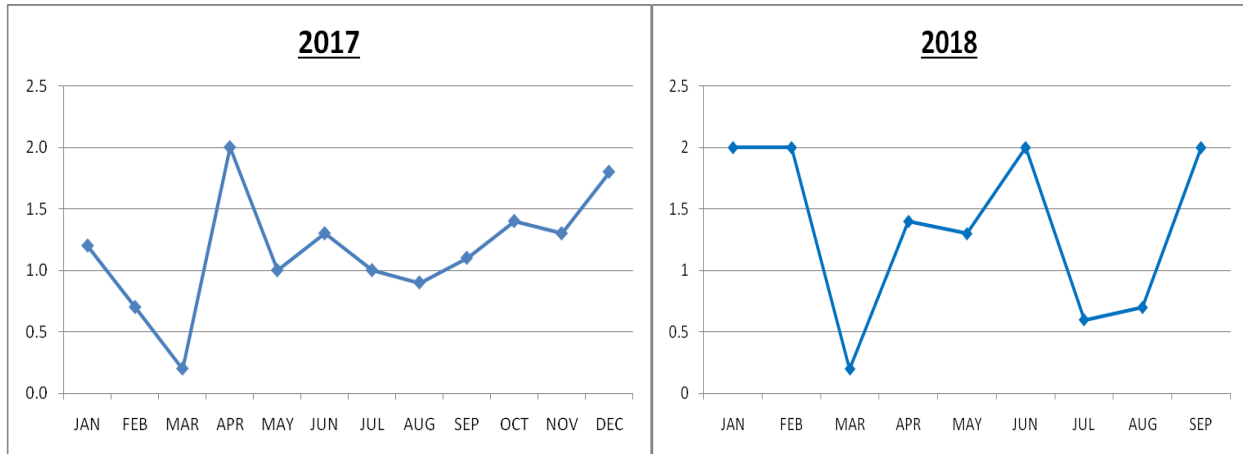
(figure 2.20 trend of the parameter pH)

**PARAMETER : D.O (mg/l)**



(figure 2.21 trend of the parameter D.O)

**PARAMETER : B.O.D**



(figure 2.22 trend of the parameter B.O.D)

**TABLE 2.2**

Code 0018	At Kalady		Monthly Monitoring				FC
	2017	pH	Cond.	DO	BOD	Nitrate N	
Unit		µhos/cm	mg/l	mg/l	mg/l	no/100 ml	no/100ml
<b>Max</b>	7.6	63	7.8	2.3	0.55	17000	5800
<b>Min</b>	6.4	30	5.7	0.8	0.08	470	220
<b>Mean</b>	6.77	37.42	6.77	1.42	0.27	3978	1658
<b>Std.Dev</b>	0.34	10.1	0.6	0.44	0.17	4505	1562

**TABLE 2.3**

Code 3468	At KWA Aluva		Monthly Monitoring				FC
	2017	pH	Cond.	DO	BOD	Nitrate N	
Unit		µhos/cm	mg/l	mg/l	mg/l	no/100 ml	no/100ml
<b>Max</b>	7.3	70	7.2	2	0.48	14000	9200
<b>Min</b>	6.4	34	4.23	0.2	0.04	200	100
<b>Mean</b>	6.8	49	6.06	1.16	0.27	3860	2137
<b>Std.Dev</b>	0.29	11.02	0.89	0.47	0.15	3938	2644

**TABLE 2.4**

Code 1338	At SDP Aluva		Monthly Monitoring				FC
	2017	pH	Cond.	DO	BOD	Nitrate N	
Unit		µhos/cm	mg/l	mg/l	mg/l	no/100 ml	no/100ml



<b>Max</b>	7.1	64	7.1	3	1.16	1400000	1300000
<b>Min</b>	6.3	33	3.9	1	0.095	600	520
<b>Mean</b>	6.68	50.67	6.03	1.78	0.43	123888	113033
<b>Std.Dev</b>	0.24	8.09	0.84	0.53	0.28	402087	373890

**TABLE 2.5**

<b>Code 2333</b>	<b>At Muppathadam</b>			<b>Monthly Monitoring</b>			
<b>2017</b>	<b>pH</b>	<b>Cond.</b>	<b>DO</b>	<b>BOD</b>	<b>Nitrate N</b>	<b>TC</b>	<b>FC</b>
<b>Unit</b>		<b>µmhos/cm</b>	<b>mg/l</b>	<b>mg/l</b>	<b>mg/l</b>	<b>no/100 ml</b>	<b>no/100ml</b>
<b>Max</b>	7.2	148	6.6	2.6	0.66	7900	6300
<b>Min</b>	6.3	45	4.7	0.5	0.05	700	400
<b>Mean</b>	6.74	66.08	5.86	1.44	0.32	2951	1840
<b>Std.Dev</b>	0.28	28.78	0.67	0.6	0.21	2391	1845
<b>Code 2334</b>	<b>At Pathalam</b>			<b>Monthly Monitoring</b>			
<b>2017</b>	<b>pH</b>	<b>Cond.</b>	<b>DO</b>	<b>BOD</b>	<b>Nitrate N</b>	<b>TC</b>	<b>FC</b>
<b>Unit</b>		<b>µmhos/cm</b>	<b>mg/l</b>	<b>mg/l</b>	<b>mg/l</b>	<b>no/100 ml</b>	<b>no/100ml</b>
<b>Max</b>	8.1	32500	9.2	5.1	2.1	7900	7000
<b>Min</b>	6.4	53	2.6	0.7	0.2	430	240
<b>Mean</b>	6.92	7747.17	5.74	2.63	0.77	4024	2642
<b>Std.Dev</b>	0.48	11759.9	1.72	1.66	0.54	2849	2262

**TABLE 2.6**

<b>Code 0017</b>	<b>At Eloor</b>			<b>Monthly Monitoring</b>			
<b>2017</b>	<b>pH</b>	<b>Cond.</b>	<b>DO</b>	<b>BOD</b>	<b>Nitrate N</b>	<b>TC</b>	<b>FC</b>
<b>Unit</b>		<b>µmhos/cm</b>	<b>mg/l</b>	<b>mg/l</b>	<b>mg/l</b>	<b>no/100 ml</b>	<b>no/100ml</b>
<b>Max</b>	7.6	39410	7	4	1.94	7900	6300
<b>Min</b>	6.4	100	4.1	0.5	0.08	1380	600
<b>Mean</b>	6.9	12527.75	5.13	2.1	0.68	3611.67	2474.17
<b>Std.Dev</b>	0.38	16063.54	0.8519	1.11	0.51	2368.9	1953.48

**TABLE 2.7**

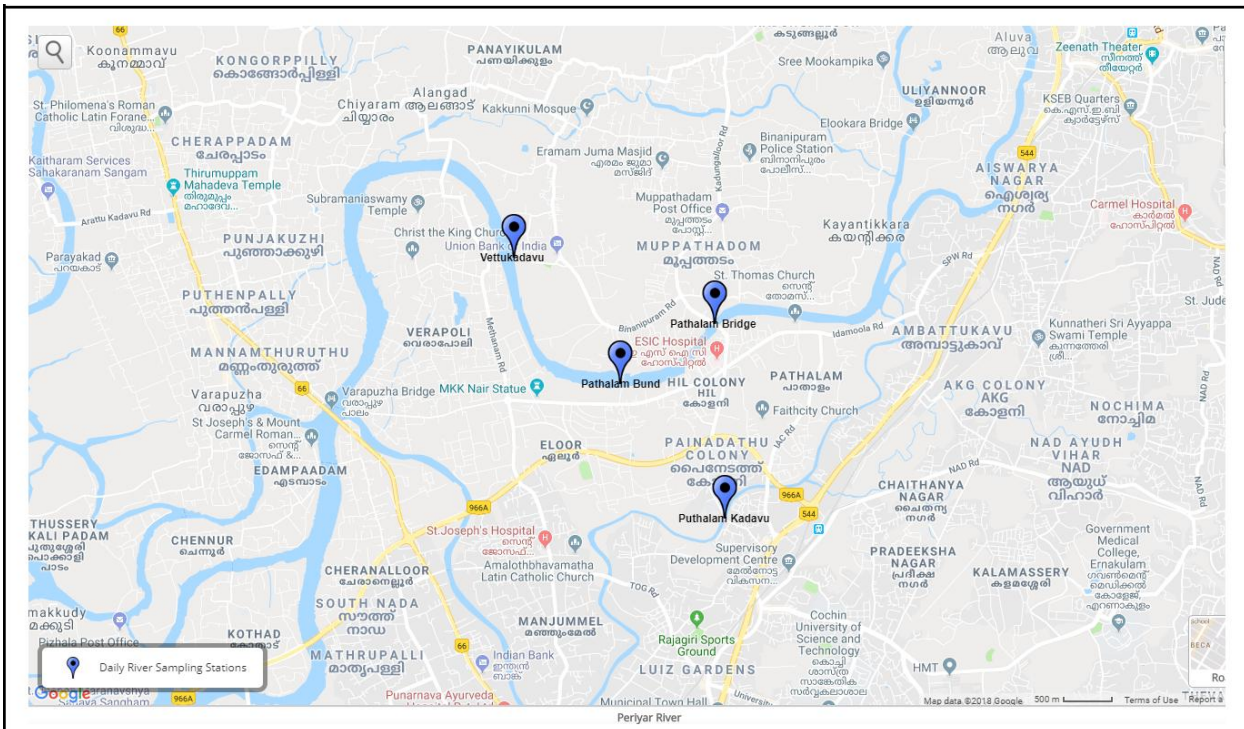
<b>Code 2335</b>	<b>At Kalamassery</b>			<b>Monthly Monitoring</b>			
<b>2017</b>	<b>pH</b>	<b>Cond.</b>	<b>DO</b>	<b>BOD</b>	<b>Nitrate N</b>	<b>TC</b>	<b>FC</b>
<b>Unit</b>		<b>µmhos/cm</b>	<b>mg/l</b>	<b>mg/l</b>	<b>mg/l</b>	<b>no/100 ml</b>	<b>no/100ml</b>

<b>Max</b>	7	170	5.7	3.7	3.37	7900	6300
<b>Min</b>	6.3	56	1.4	0.6	0.01	1060	640
<b>Mean</b>	6.52	88.75	3.72	2.08	0.79	4118	2553
<b>Std.Dev</b>	0.23	35.51	1.5	0.9	1.21	2404	1908

**2.2 (b) SAMPLING POINTS AT INDUSTRIAL BELT ELOOR**

**TABLE 2.8**

SI No	NAME OF LOCATION	FREQUENCY
1	Vettukadavu	DAILY
2	Pathalam Bridge	DAILY
3	Pathalam Bund cum Regulator	DAILY
4	Puthalam Kadavu	DAILY

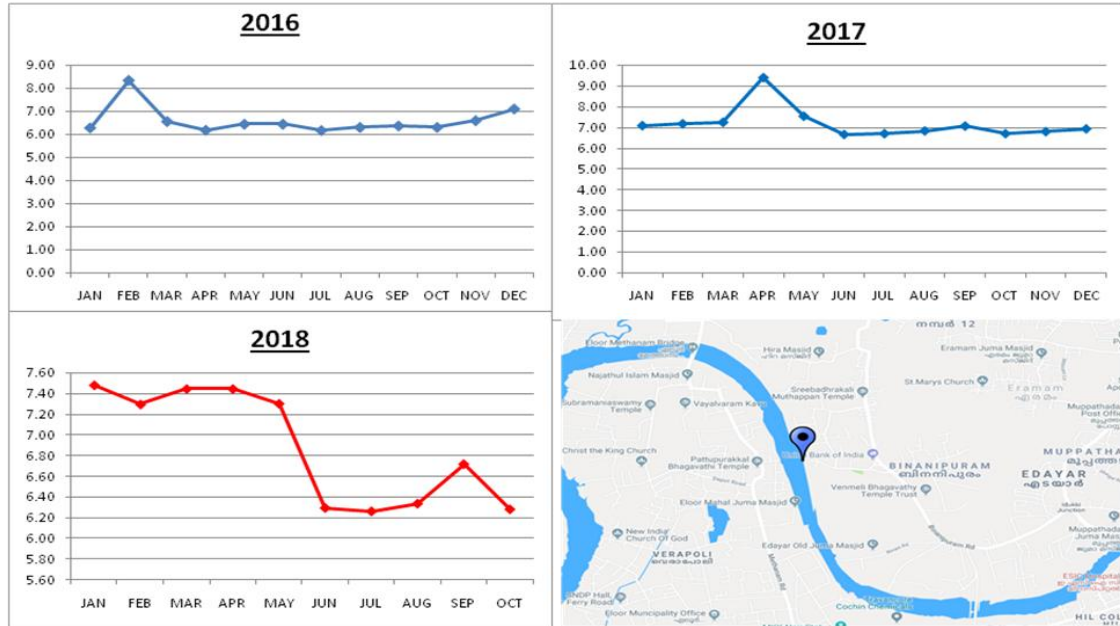


**Fig 2.23 MAP OF DAILY SAMPLING STATIONS INDUSTRIAL BELT ELOOR**

# ANALYSIS REPORT OF INDUSTRIAL BELT ELOOR

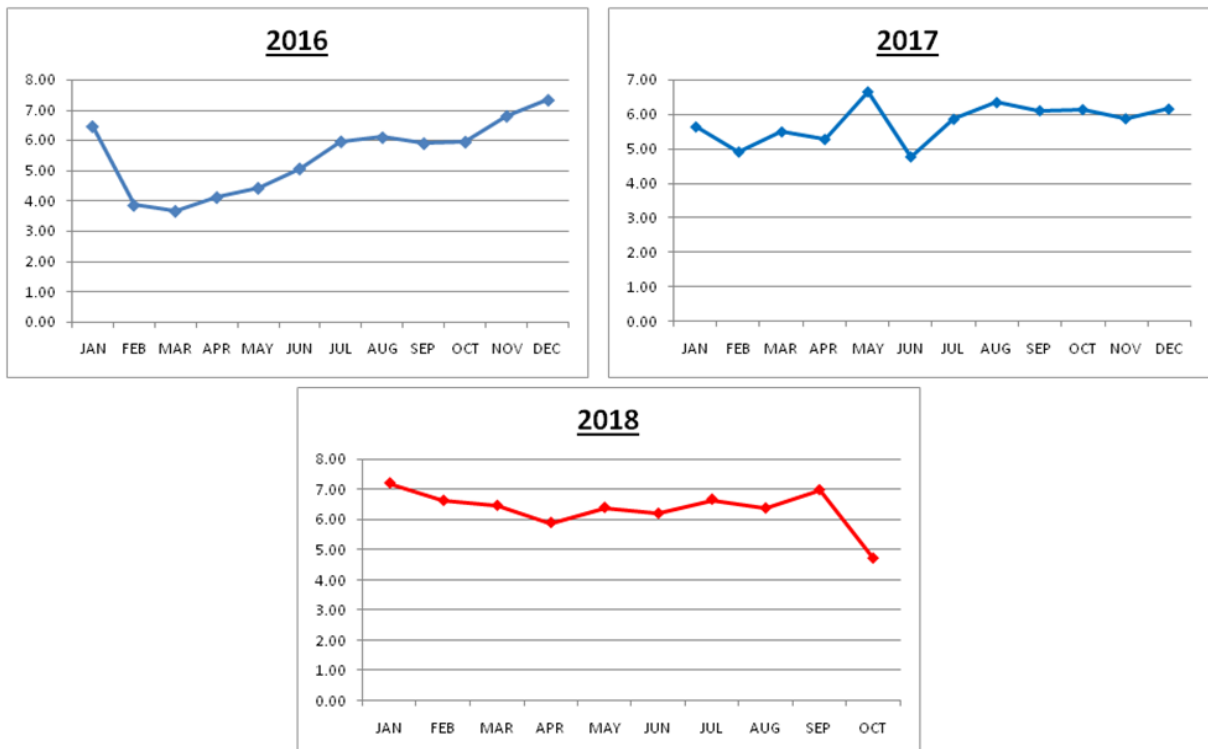
## SAMPLING POINT-1 VETTUKADAVU

### PARAMETER : PH



(figure 2.24 trend of the parameter pH)

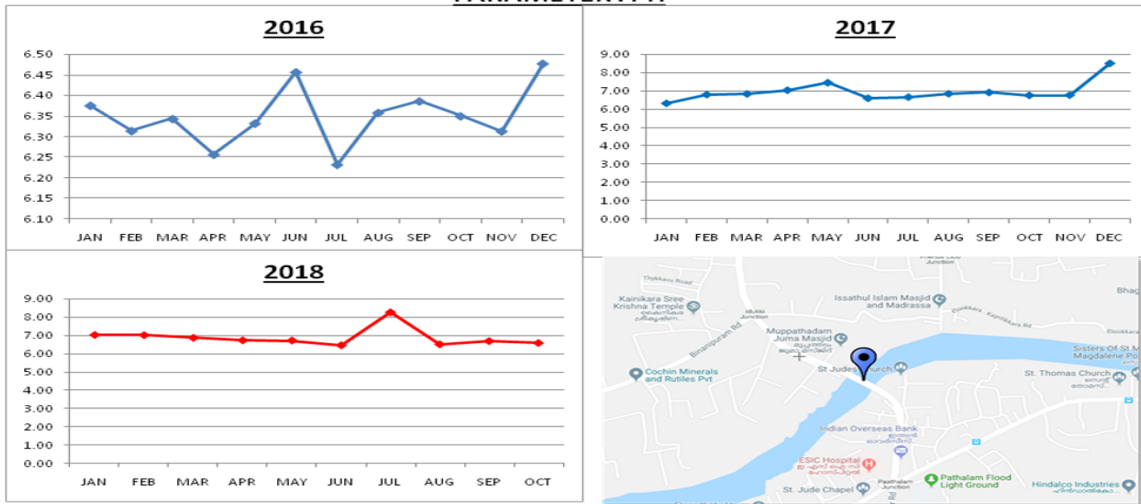
### PARAMETER : D.O (mg/l)



(figure 2.25 trend of the parameter D.O)

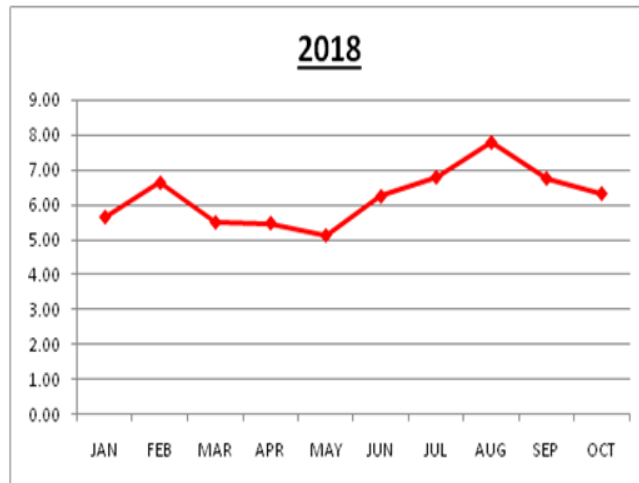
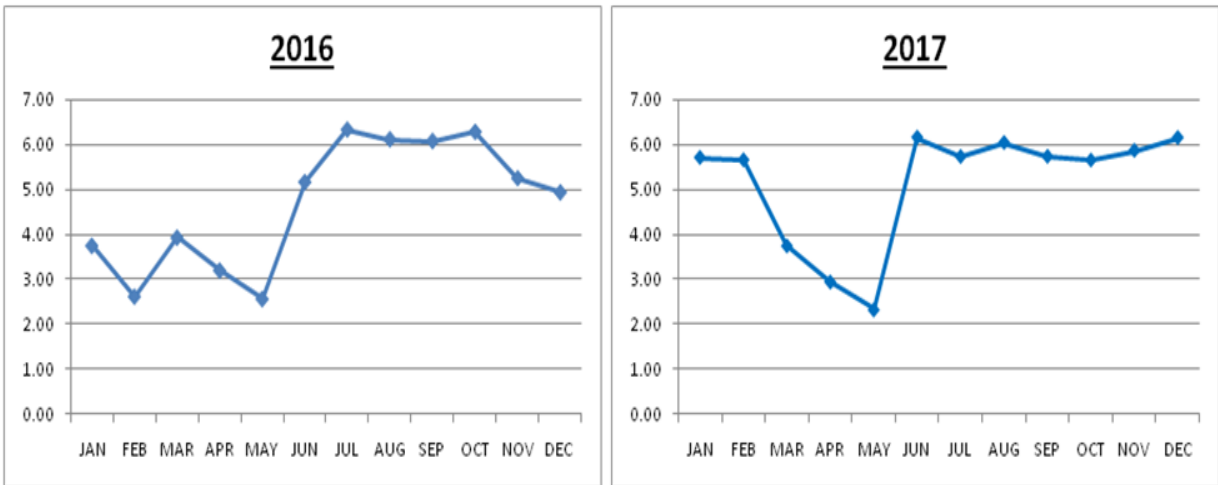
## SAMPLING POINT-2 PATHALAM BRIDGE

**PARAMETER : PH**



(figure 2.26 trend of the parameter pH)

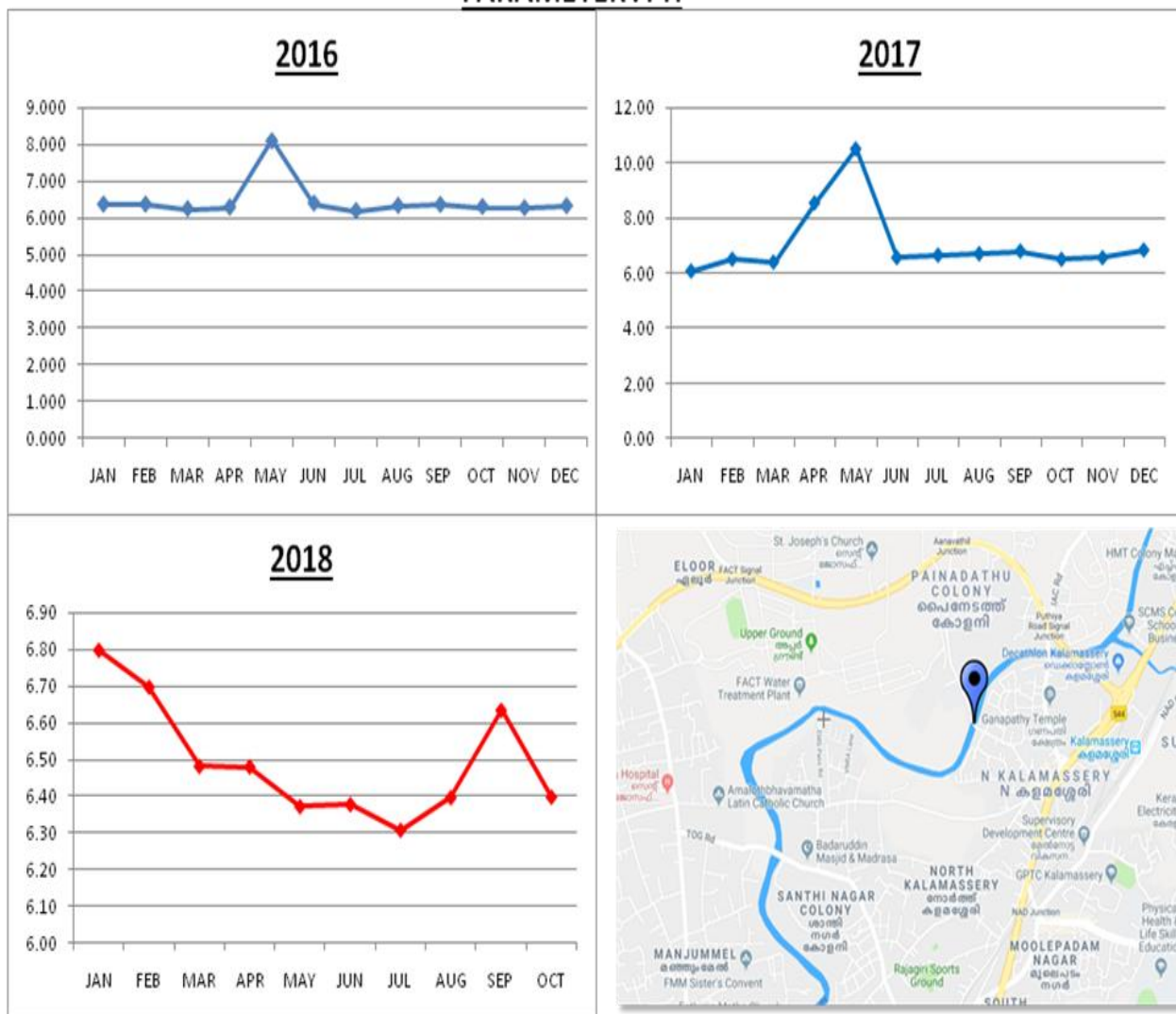
**PARAMETER : D.O (mg/l)**



(figure 2.27 trend of the parameter D.O)

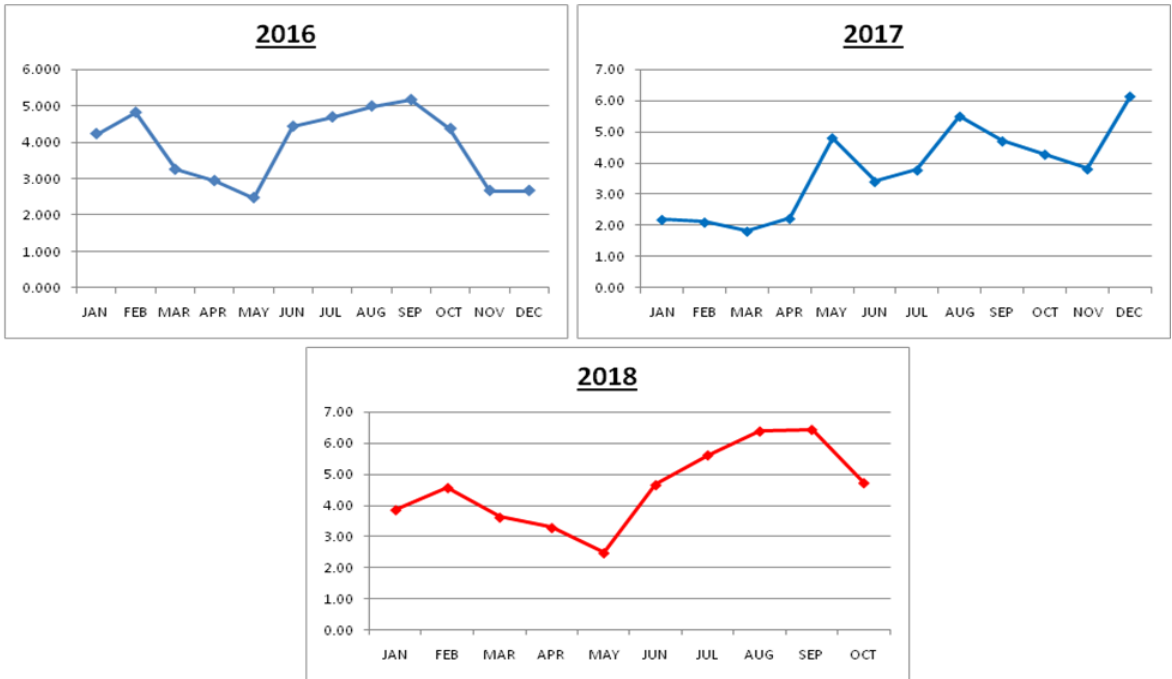
# SAMPLING POINT-3 PUTHALAMKADAVU

## PARAMETER : PH



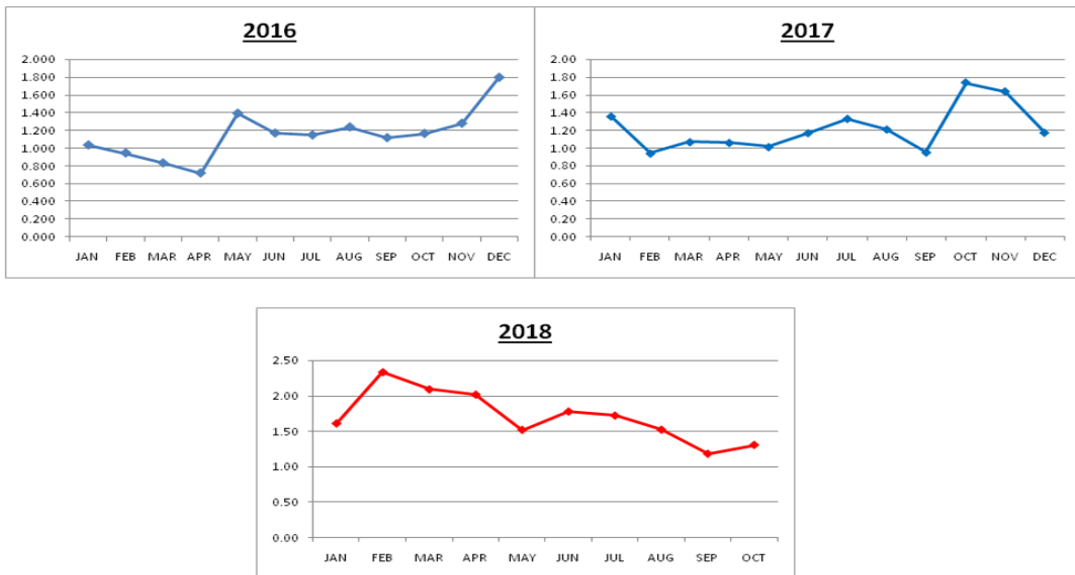
(figure 2.28 trend of the parameter pH)

**PARAMETER : D.O (mg/l)**



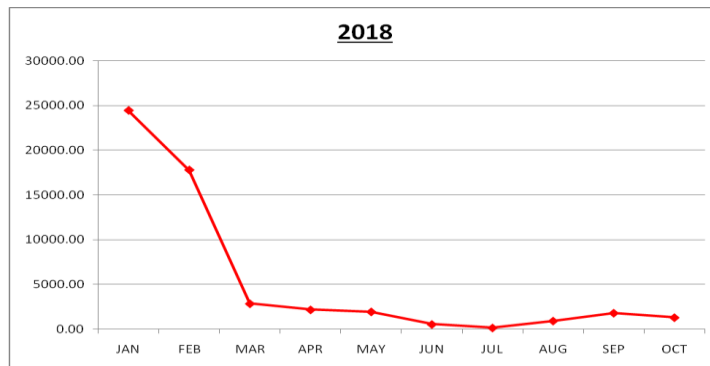
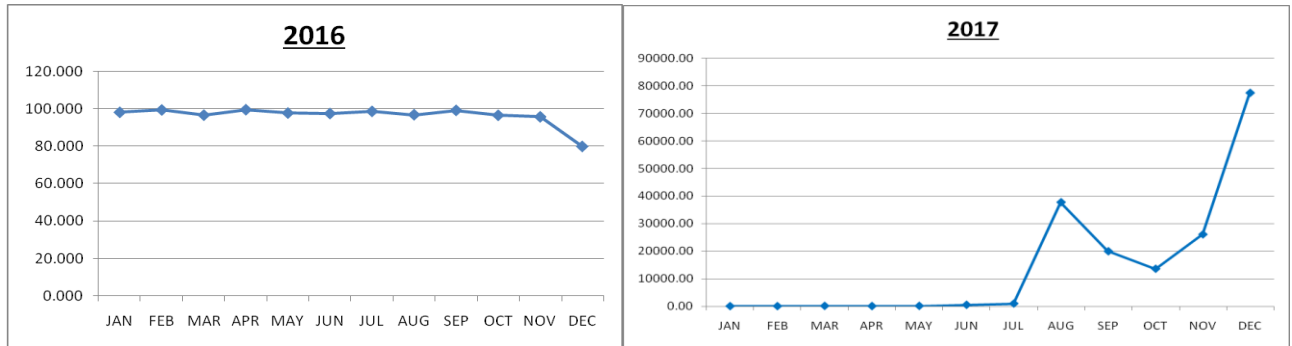
(figure 2.29 trend of the parameter D.O)

**PARAMETER : B.O.D**



(figure 2.30 trend of the parameter B.O.D)

**PARAMETER: TOTAL COLIFORM (CFu/ml)**



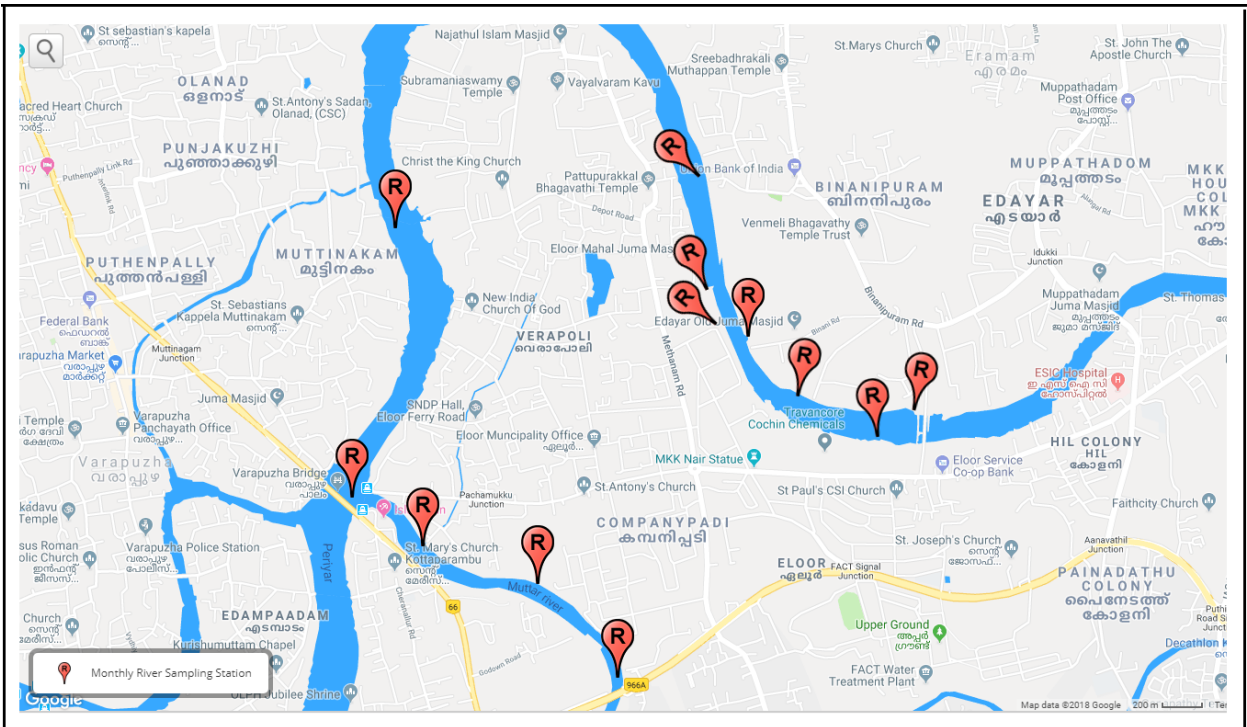
**(figure 2.31 trend of the Total coliform)**



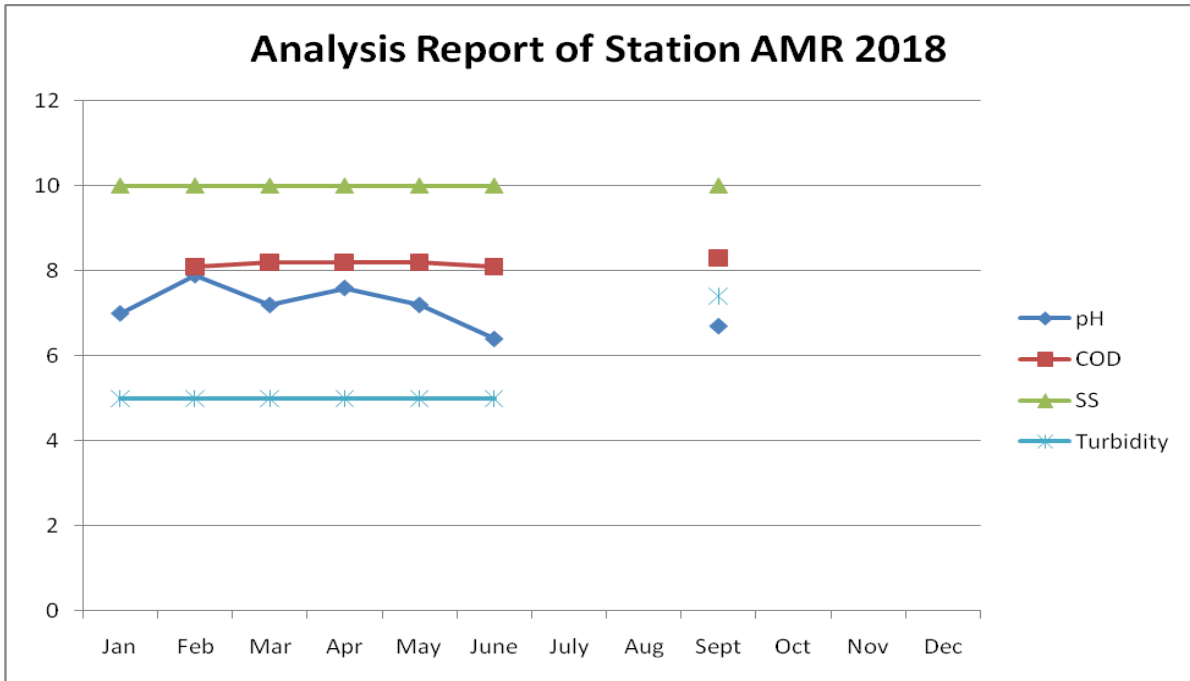
**TABLE 2.9**

**2. SAMPLING LOCATIONS AT INDUSTRIAL DISCHARGE OUTLET POINTS**

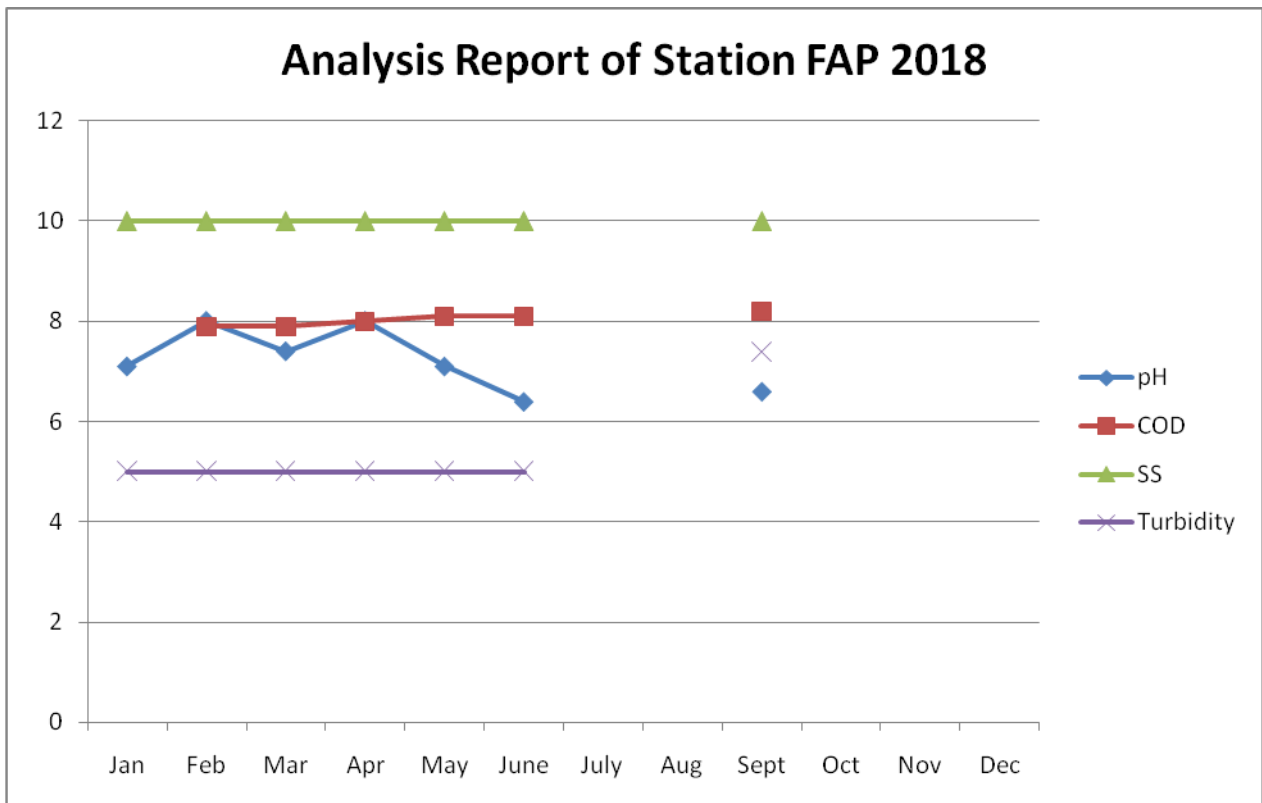
SI No	NAME OF LOCATION	Station Code	FREQUENCY
1	Amrutha pumping station	AMR	MONTHLY
2	FACT PD	FAP	MONTHLY
3	Kuzhikandam thodu	KUT	MONTHLY
4	Eloor Ferry	ELF	MONTHLY
5	Muttinakam	MUT	MONTHLY
6	Vettukadavu	VET	MONTHLY
7	IRE outlet	IRE	MONTHLY
8	FACT UD Outlet	FAU	MONTHLY
9	BINANI outlet	BIN	MONTHLY
10	SUDCHEMIE outlet	SUC	MONTHLY
11	CMRL outlet	CMRL	MONTHLY
12	TCC outlet	TCC	MONTHLY



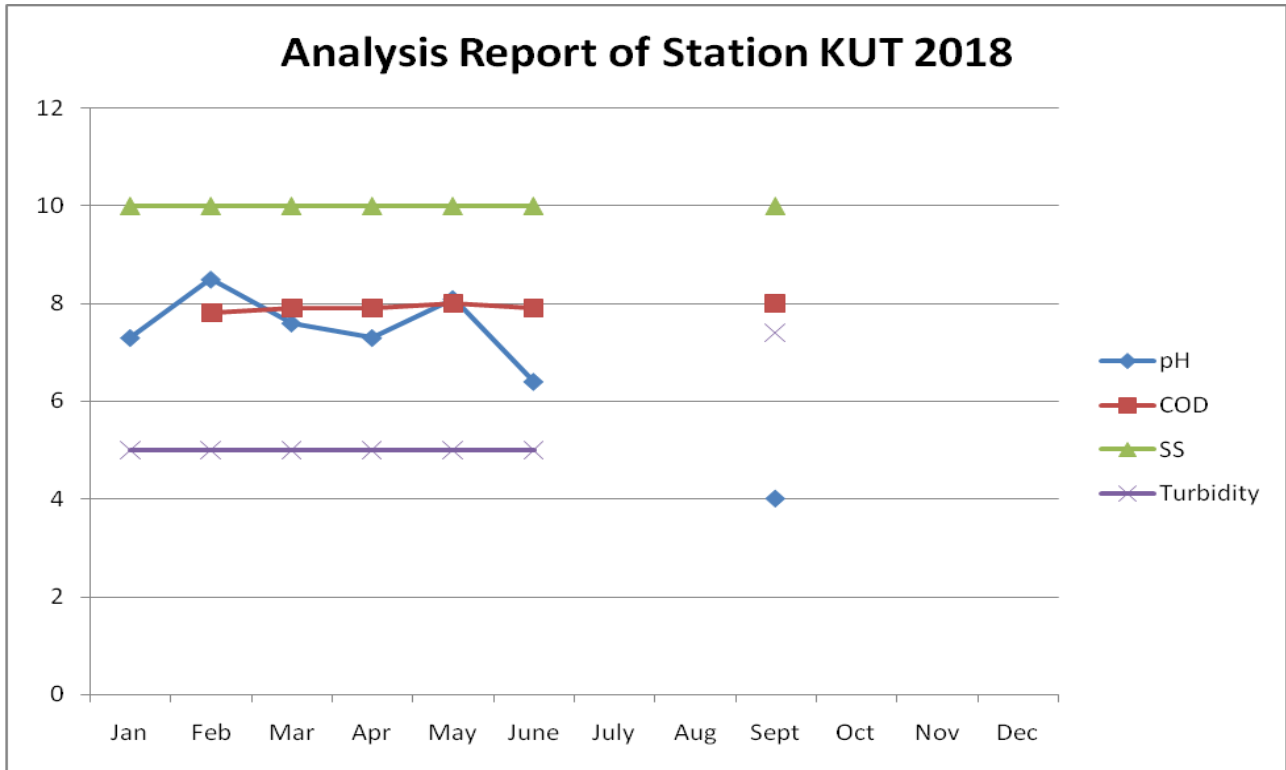
**FIG:2.32 MAP OF SAMPLING LOCATIONS AT INDUSTRIAL DISCHARGE OUTLET POINTS**



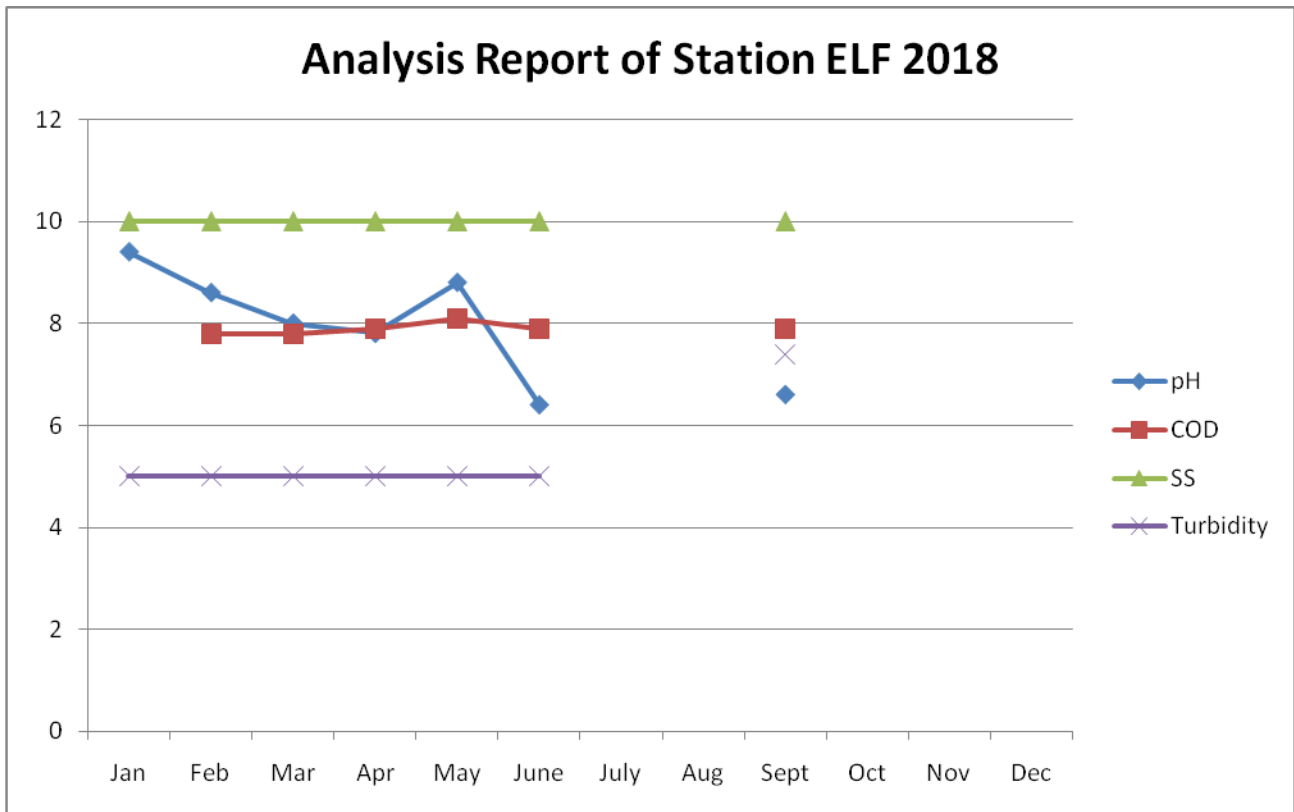
**FIG:2.33**



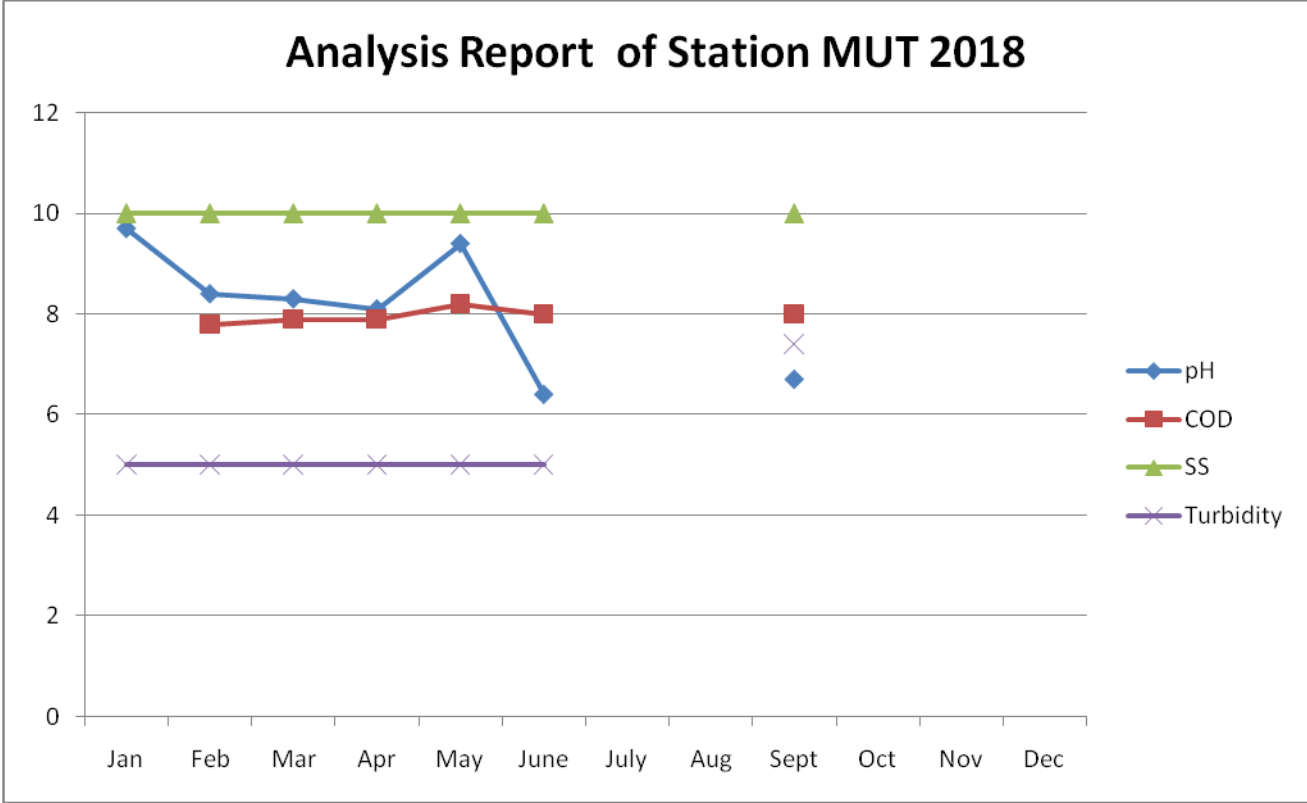
**FIG :2.34**



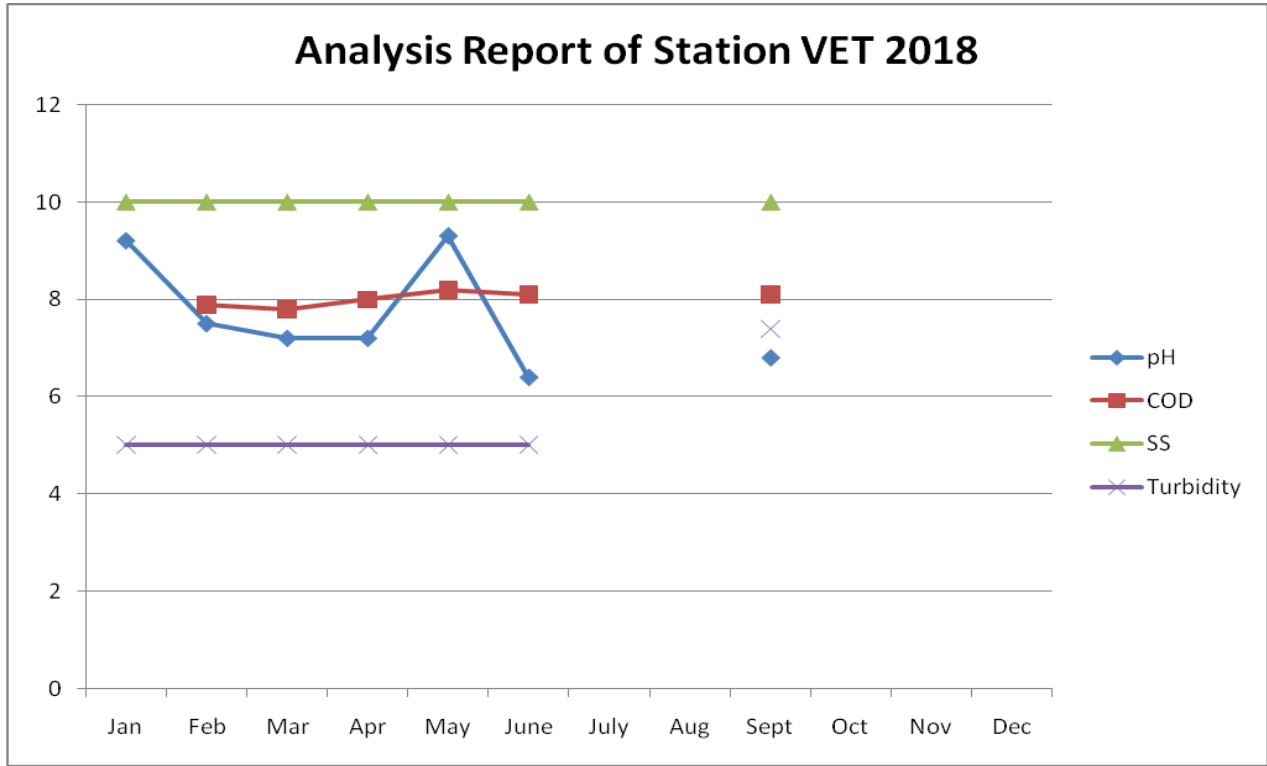
**FIG:2.35**



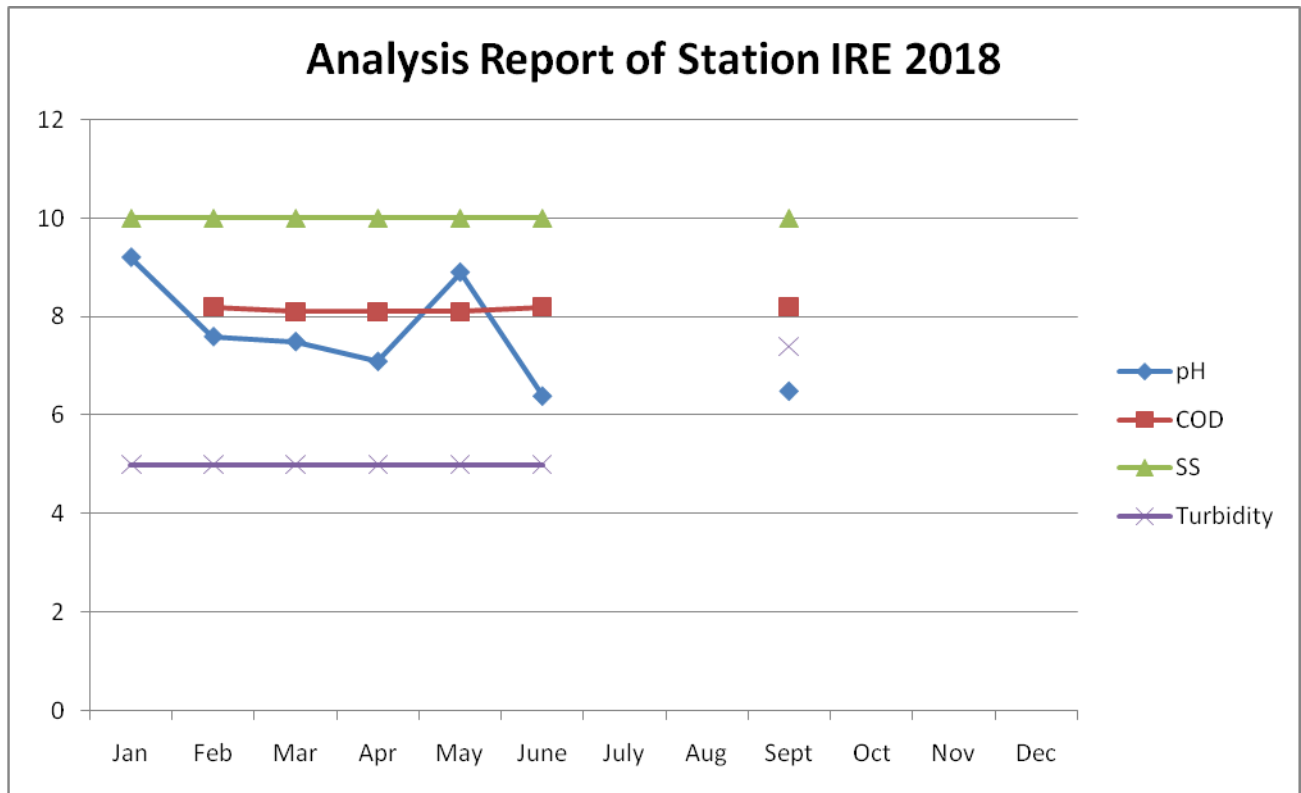
**FIG:2.36**



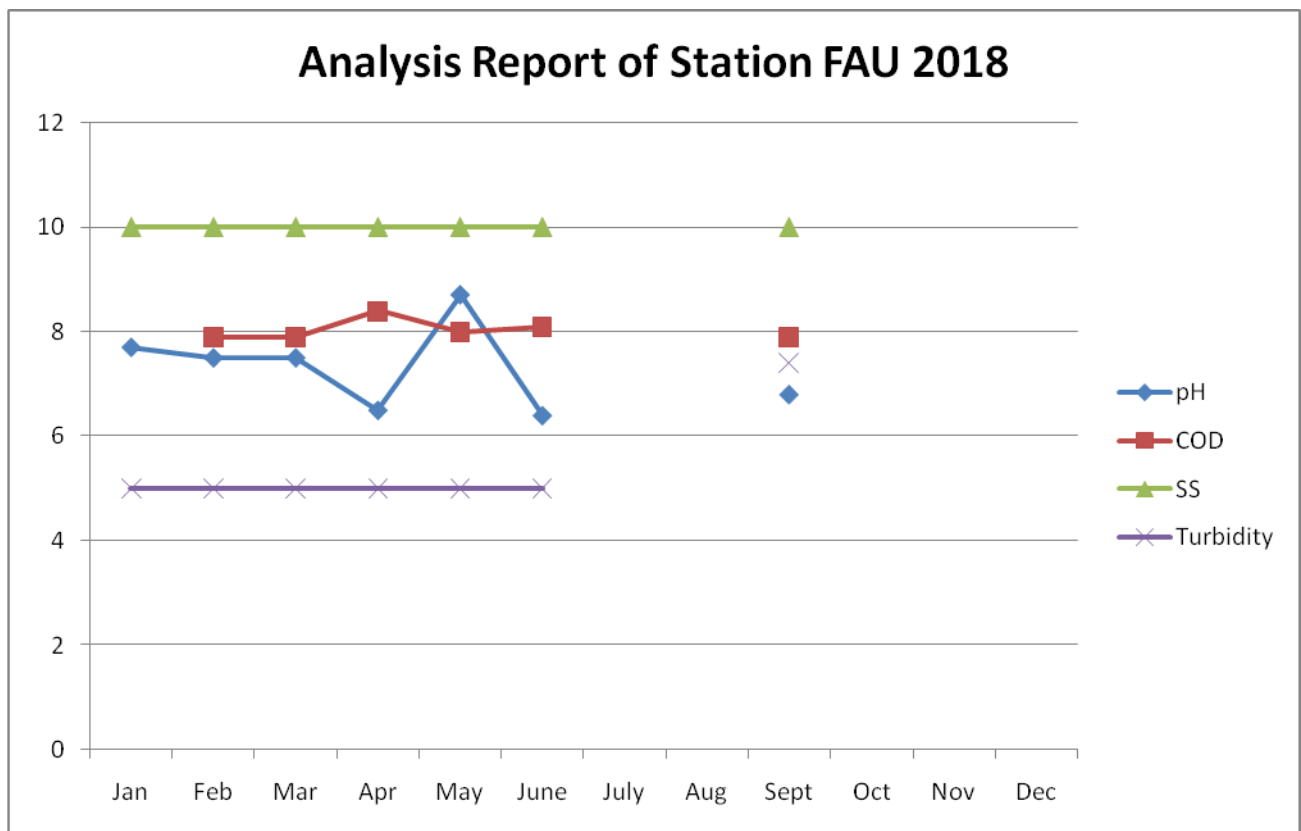
**FIG:2.37**



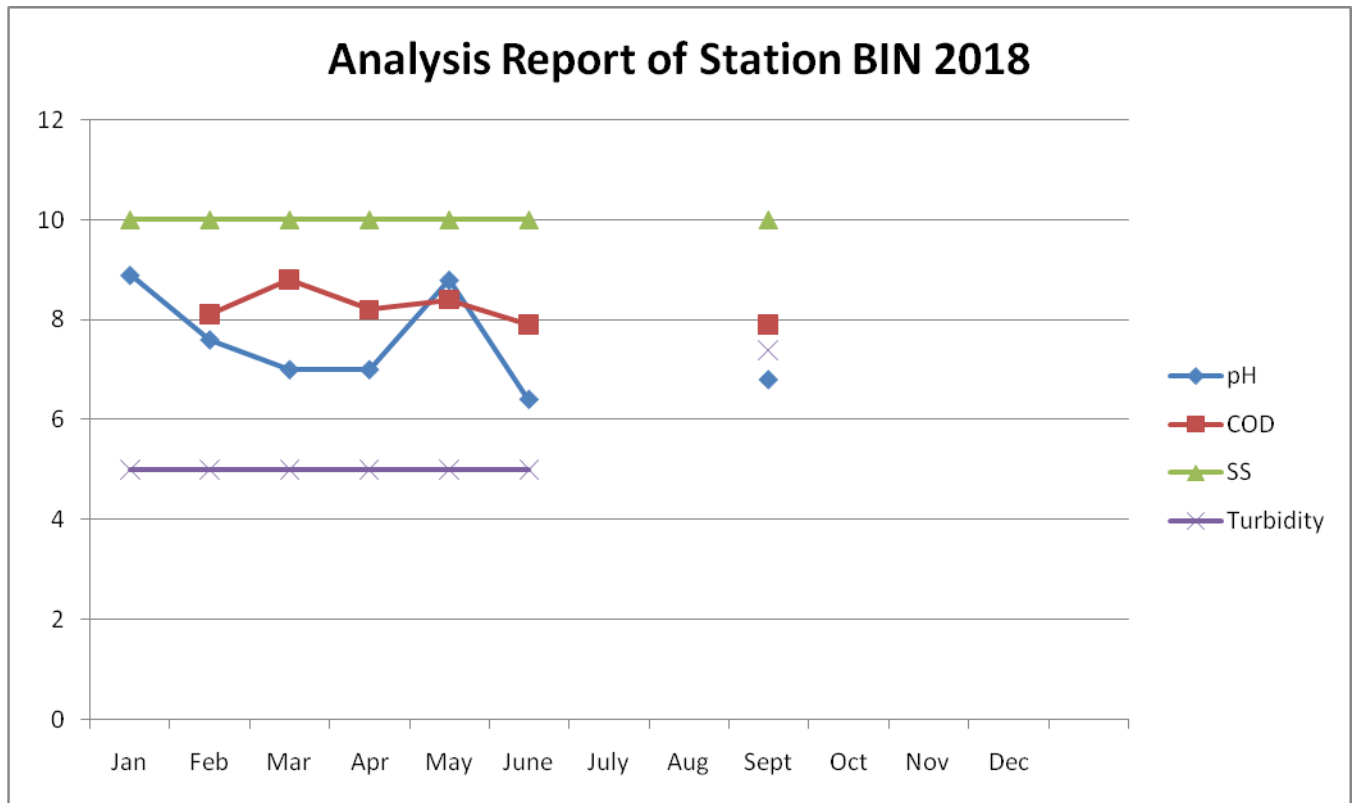
**FIG:2.38**



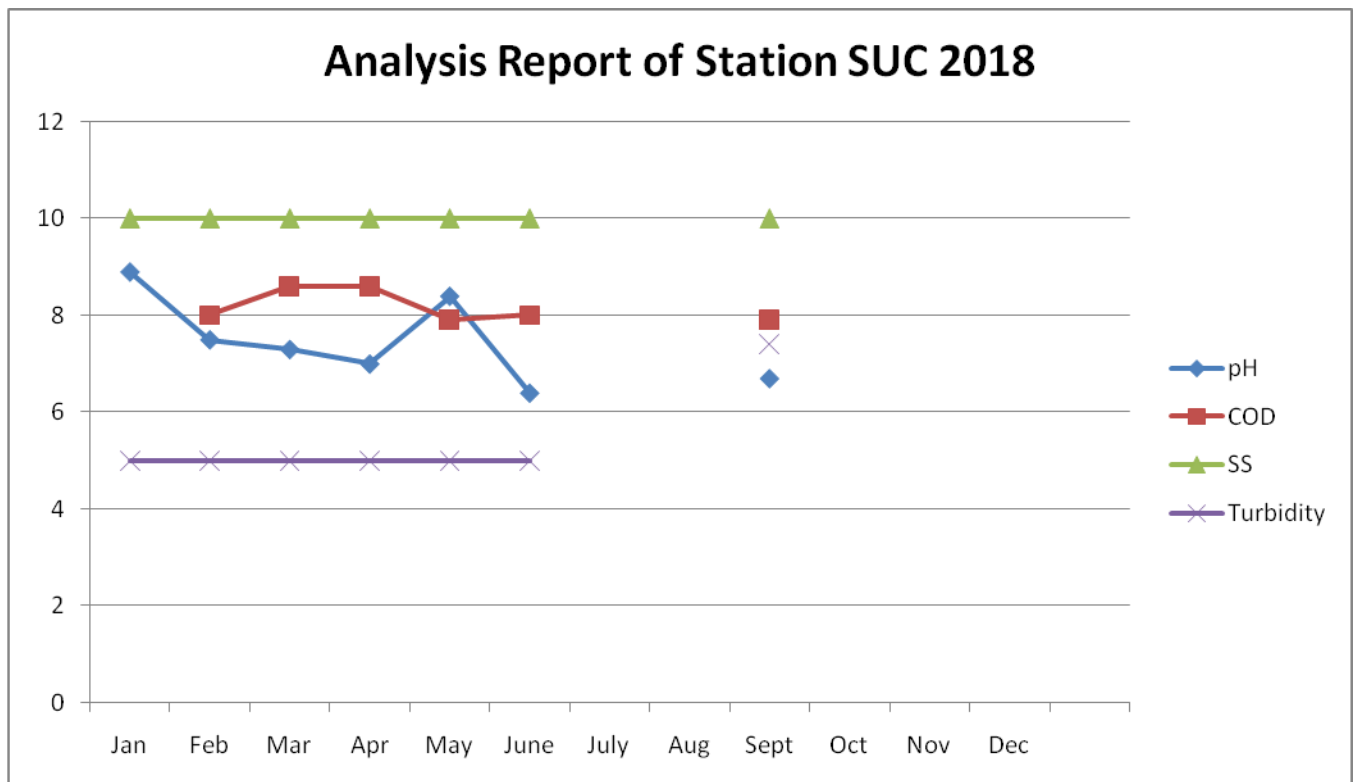
**FIG:2.39**



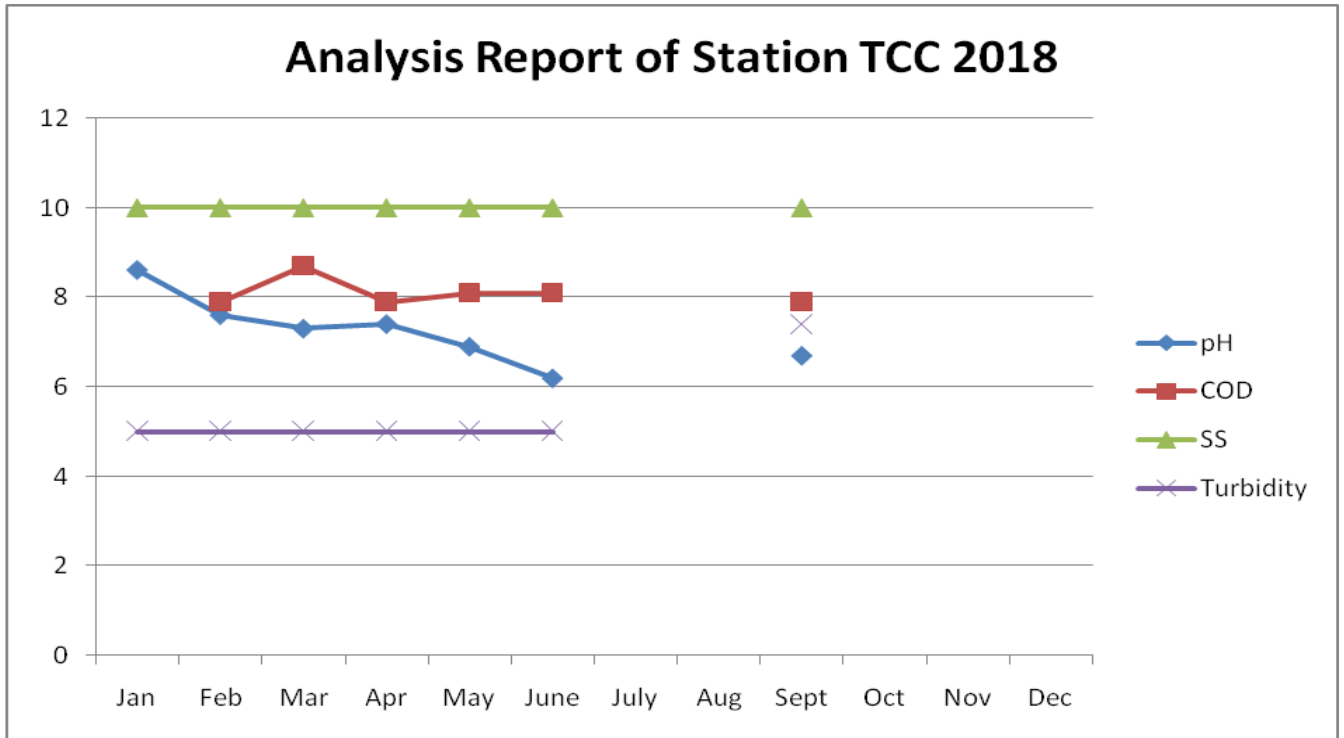
**FIG:2.40**



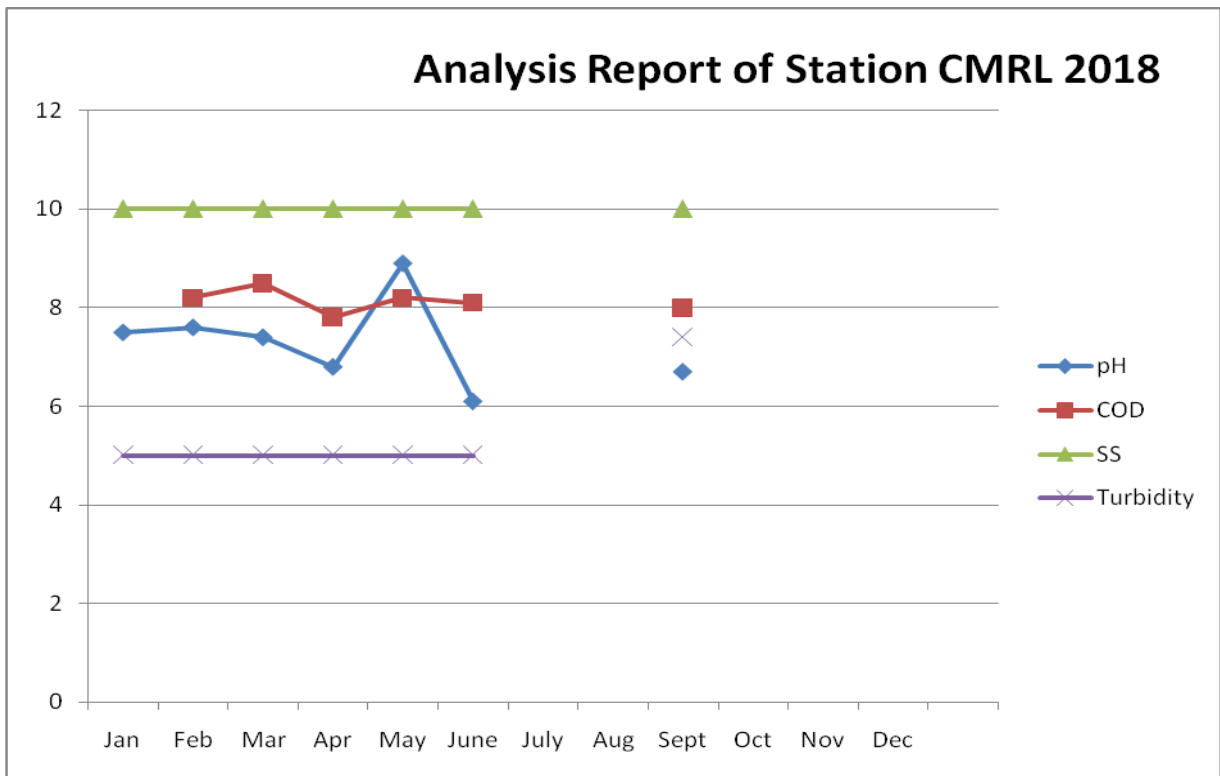
**FIG:2.41**



**FIG :2.42**



**FIG:2.43**



**FIG:2.44**

**TABLE 2.10****New Locations selected for the study in polluted stretch**

SI No	NAME OF LOCATION	FREQUENCY
1	Neriamangalam near Sreedharma Sastha college	3-4 Days
2	Periyar at Panamkutty Bridge	3-4 Days
3	Mahilalayam Thuruth Bridge	3-4 Days
4	Kadathu Kadavu	3-4 Days
6	Thynothil Kadavu	3-4 Days
8	Uliyannoor Bridge	3-4 Days
9	Amity Periyar Sarovar Apartments	3-4 Days
11	Mary Queen Help of Christian	3-4 Days
13	Periyar Heritage villas and flat	3-4 Days
14	Idamula Bridge	3-4 Days
15	Kayanitikkara Kadavu	3-4 Days
18	Perfect Honda	3-4 Days

**TABLE 2.11****Parameters measured along the stretch of Periyar from Panamkutty to Kayantikkara**

Sl.No	Stations	Parameters		
		pH mg/l	BOD mg/l	Total Coliform CFU/100ml
1	Panamkutty Bridge	6.7	2.3	7400
2	Neriamangalam	6.3	2.0	6400
3	Mahilalayam Thuruth Bridge	7.2	2.1	4200
4	Aluva Manappuram	7	2.5	1408
5	Kadathu Kadavu	7.2	2.3	4400
6	Thynothil Kadavu	7.3	2.9	3800
7	Uliyannoor Bridge	7.4	2.1	4200
8	Amity Periyar Sarovar Apartments	7.2	2	3600
9	Mary Queen Help of	7.2	2.3	2800



	Christian			
10	Periyar Heritage villas and flat	7.1	2.1	4000
11	Idamula Bridge	7.1	2.0	3600
12	Kayanitikkara Kadavu	7.5	2.8	4100
13	Perfect Honda Kalamassery	7.1	2.3	2500

### **2.3.Industrial Belt Eloor**

Eloor is an island of 11.21km<sup>2</sup> in which most of the industries of the area are situated. The Eloor-Edayar region about 20 km from the point where the Periyar river meets the Lakshadweep Sea, is the industrial Hub of Kochi. There are 280 industries in Eloor Edayar industrial belt which includes 112 RED Category, 46 Orange Category industries operating in the Industrial Estate. Board had given permission for 8 industries to discharge the treated effluent to river Periyar in which 7 industries have outlets ay the downstream of Patahram Bund where the river is classified under class E. Only one industry is discharging to the upstream of Pathalam bund which is classified as class C. The details of industries are given below.

**TABLE 2.12**

<b>SL NO</b>	<b>Name Of User</b>	<b>Water Consumption KL/day</b>	<b>Qty. Of effluent discharge KL/day</b>	<b>Discharge Point</b>
1	Cochin Minerals and Routines Ltd, IDA, Edayar, Muppathadam P.O.	1995	659	Discharge to the downstream of Pathalam regulator cum bridge. pH meter installed in the storm water drain
2	FACT-Petro Chemical Division, Eloor	13970	5040	Discharge to the downstream of Edamula branch

3	FACT- Udyogmandal Division, Eloor	48000	Outlet A – 12000 Outlet I – 4800	Discharge to the downstream of Pathalam regulator cum bridge
4	HINDALCO Industries Ltd, Alupuram, Kalamassery – 683104	801	4	No water used in process. STP provided for the domestic waste water and treated waste water used for gardening.
5	Indian Rare Earths Ltd, Eloor Udyogamandal P.O.	270	130	Discharge to the downstream of Pathalam regulator cum bridge
6	Sud Chemie India Pvt. Ltd IDA Edayar Binanipuram P.O.	450	450	Discharge to the downstream of Pathalam regulator cum bridge
7	TMS Leathers IDA Edayar, Muppathadam P.O.	12.36	10.1	Discharge to the upstream of Pathalam regulator cum bridge
8	Travancore Cochin Chemicals Limited P.B. No. 4004 Eloor, Udyogamandal P.O.	535.4	100	Entire treated effluent re-used only storm water being discharged to the river. pH meter installed in the storm water drains

**TABLE 2.13**

**Quantity of water taken from River Periyar**

Sl.No.	Name Of User	Water Consumption	Intake point
1	M/s. Hindalco Industries Ltd., Eloor	1017 KLD	Edamula
2	M/s. Travancore Cochin Chemicals, Udyogamandal	4200 KLD	Edamula

3	M/s. Hindustan Insecticides Ltd., Eloor, Udyogamandal	550 KLD	Edamula
4	M/s. Fertilizers And Chemicals Travancore Limited, Eloor, Udyogamandal	14297 KLD	Edamula
5	M/s. BPCL Kochi Refinery, Ambalamugal, Kochi	60 MLD (2500m <sup>3</sup> /hr)	Edamula
6	M/s. Carborundum Universal Ltd., Kalamassery	1175 KLD	Edamula
7	M/s. Amrita Viswa Vidyapeetham (Amrita Hospital), Kochi	97,000 lit/day	Edamula
8	KINFRA	875 KLD	Edamula
9	Aluva Pump House	290 MLD	Aluva

### **3. IDENTIFICATION OF POLLUTION SOURCES**

About 25% of the units in Kerala are located in the Ernakulam district on the banks of River Periyar. In Ernakulam district there are five major industrial estates namely Angamaly, North & South Kalamassery, Eloor and Edayar. The major water polluting units are located at the lower stretch of River Periyar. After bifurcation of Periyar river into two branches near Kalamasery, viz Edamula branch and Eloor branch. Both these branches join together at Eloor ferry and finally discharge to Arabian sea. There are three Regulator cum bridge(RCB)/bund constructed in the River Periyar which are considered as outlets of River to the sea. This bund/regulator prevents the entry of saline water during high tide to the upstream of the river. A Regulator cum bridge is constructed near Manjaly bridge (known as Purappallykkavu bund) which is at Mangalpuzha branch, a Regulator cum bridge (Pathalam bund) is also constructed at Pathalam in the downstream of Pathalam bridge which is at Eloor stream. In the Edamula branch a permanent regulator is in operation at Manjummel. The Eloor- Edayar industrial areas are situated at the banks of Eloor stream of River Periyar. Pumping stations of major industries such as M/s TCC, M/s FACT, M/s BPCL Refinery, M/s Hindalco, M/s Amritha Hospital etc are situated in Edamula stream. Industries are located along the banks of Periyar and concentration of these industries is within a stretch of 5 km in the Eloor–Edayar area. These industries depend on the river for intake of process water and disposal of effluents. All major industries in Eloor area are located downstream of the bund and some industries are located in the upstream of bund but just downstream of the Pathalam bridge.

There are about 30 industries in Eloor industrial area and 247 industries in Edayar industrial Estate. The major industries in Eloor-Edayar industrial belt includes Hindustan Insecticide Limited (HIL), Fertilizers and Chemicals Travancore Ltd. (FACT), Indian Rare Earths Ltd. IREL, Travancore Cochin Chemicals, Cochin Minerals and Rutile Ltd (CMRL), Hindalco, Arjuna

Natural Extracts etc., other industries are small scale industries. In Eloor Edayar industrial belt, 35 Industries are effluents generating industries, other industries are having dry process. All the effluent generating industries have installed Effluent treatment Plant. There are 26 industries (3 industries closed) situated at the banks of river in which 14 industries are effluent generating industries, eight industries have been allowed to discharge their treated effluent to river Periyar namely FACT Fertilizer Division and Petrochemical division, IREL, CMRL, Sreesakthi Paper Mills, TMS Leathers, Edayar Zinc (former Binani Zinc) and Merchem. At present, Edayar Zinc, Sree sakthi Paper Mills, Merchem is closed and not discharging the effluents to river. FACT Petrochemical division is closed since 2012. All industries except TMS leathers are discharging their treated effluent to the downstream of Pathalam RCB. Kerala State Pollution Control Board office at Eloor is operational in 24 hrs and also have surveillance team. The officers are in duty during night hours also and continuously monitoring the industries. In case of any discharge noted from industries, stringent action being taken against the defaulters. Board had also installed surveillance cameras at the bank of River Periyar for finding any unauthorized discharge to the river.

The regulators at the Periyar River is closed during summer and opened to reduce the salinity in fresh water. Closing of the regulators leads to stagnation of water which in turn causes the deposition of nutrients especially Phosphates and Nitrates in river bed. Excessive deposition of nutrients causes Algal bloom. The algal bloom later decays and putrify changing the colour of river into black and it causes the oxygen depletion causing "Eutrophication". This causes fish death in the river. The regulators need to be operated routinely as per the tidal chart so as to prevent Eutrophication. The Algal bloom is noted in both stretches of Edamula and Edayar stream. Thoombungal thodu which joins River Periyar at Edamula carries high concentration of organic load generated due to decay of vegetation from near by wet land at NAD, Kalamassery. The main

source of this organic load is originated from the decay of the grasses of wet land and unauthorized septage dumping is also suspected in these areas. The unauthorized dumping need to be prevented by night surveillance. As pumping stations are located at the Edamula stream, more priority need to be given to pollution control of this stretch. Hence, the action plan for rejuvenation of polluted stretch of Periyar “Aluva-Kalamassery-Eloor Ferry” has to be prepared considering all the above factors and control of all types of pollutant sources.



**Drain carrying Sewage from Kalamassery Market joins at Periyar river at Puthalamkadavu**



**Non- Operational STP of Aluva Municipality near Ashramam**



**Algal Bloom noted in river Periyar on 16.03.2019**



Oil scum generated from decay of vegetation at wet lands of NAD Kalamassery flowing through Thoombungal Thodu



Oil scum generated from decay of vegetation at wet lands of NAD Kalamassery flowing through Thoombungal Thodu





**Edappally thodu carrying sewage joins at River Periyar at downstream of Manjummal**

#### 4. DISTRICT LEVEL TECHNICAL COMMITTEE

**3.1.** River Water is considered to be fit for bathing when it meets the criteria of having Biochemical Oxygen Demand (BOD) less than 3.0 mg/L, Dissolved Oxygen more than 5.0 mg/L and Faecal Coliform bacteria to be less than 500 MPN/100 ml. according to latest assessment by the CPCB, there are 351 polluted river stretches in India i.e. where the BOD content is more than 3mg/L. The plan of CPCB is to target enhancement of river flow. The plan for restoration of polluted river stretches is proposed to be executed through two-fold concepts. One concept is to target enhancement of river flow through interventions on the water sheds/catchment areas for conservation and recharge of rain water for subsequent releases during lean flow period in a year. This concept will work on dilution of pollutants in the rivers and streams to reduce concentration to meet desired level of water quality. Other concept is of regulation and enforcement of standards in conjunction with the available flow in rivers /streams and allocation of discharges with stipulated norms. Honourable NGT on O.A No. 673/2018 had directed that All States and Union Territories shall prepare action plans within two months for bringing all the polluted river stretches to be fit at least for bathing purposes (i.e BOD  $\leq$  3 mg/L and FC  $\leq$  500 MPN/100 ml) within six months from the date of finalization of the action plans. Govt. had constituted a District Level Technical Committee for preparing the draft action plan for the rejuvenation of River comprising of the following members.

1. The Superintending Engineer, Irrigation department- Chairperson
2. The Superintending Engineer, Kerala Water Authority-Member
3. The Environmental Engineer, Pollution Control Board, District Office-member & Convenor
4. The District Coordinator, Suchitwa Mission-Member
5. The General Manager, Industries Department-Member
6. The Senior Officer representing Revenue Department-Member
7. Secretary of Corporation/municipality-Member
8. Secretary of Grama Panchayath-Member

The committee had convened a meeting on 20.05.2019 and conducted joint inspection to know the sources of pollution. The committee visited the various drains carrying sewage which joins the river periyar. The committee also visited the Thoombungal thodu,

Kalamassery dumping yard, wet lands at NAD , and also drain at Eloor and Edappally thodu which contribute high organic load to river. Later, the committee visited the industrial area at Edayar and Pathalam Bund. Based on the visit, the committee opined that action plan shall be prepared considering all types of pollution such as sewage from townships, hotels,flats, commercial buildings and industries including all concerned departments. The committee prepared a detailed action plan for the restoration of the river. The action plan prepared contains short term and long term measures.

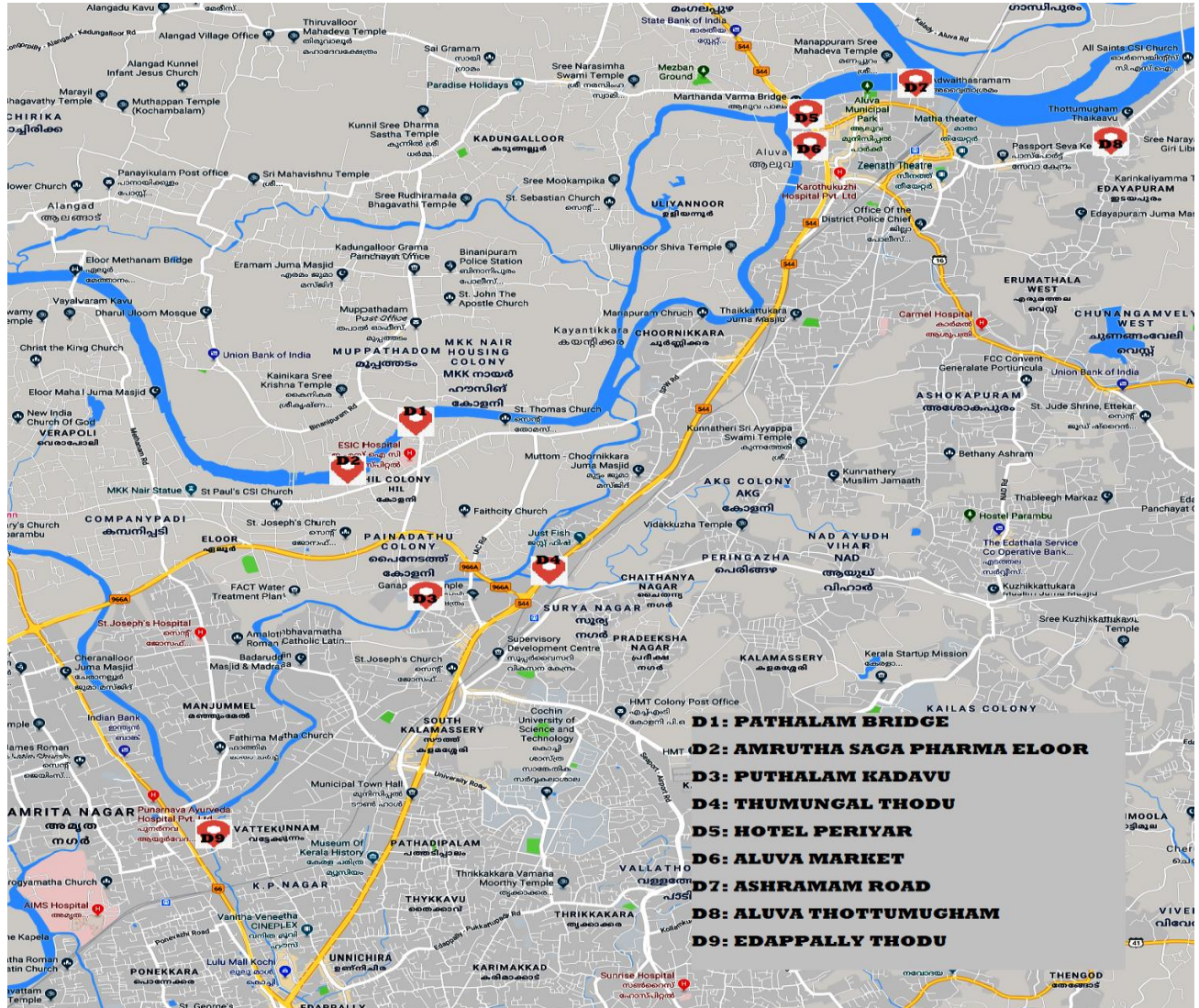
### 3.2. POLLUTION LOAD CALCULATION

The monitoring report shows the BOD level in the river from the upstream side is average 2.0mg/lit. Various drains are seen joined in the River carrying sewage which reaches river Periyar. The industrial belt is located at downstream of the River at Eloor stream. The main reason for the increase in BOD Load in river at upstream side is found to be due to the discharge of untreated sewage to the River. In the circumstance, the drains reaching the river were located and samples were collected from the drains to calculate the pollution load to the river based on the flow. The details are as follows.

**TABLE 3.1**

Sl. No.	Location	Area of Flow (Sqm)	Discharge(L/Day)	BOD(mg/l)	BOD(Tonne/Day)	COD(mg/l)	COD(Tonne/Day)
1	Amrutha Sag Pharma, Eloor	0.2	1382400	100	0.138	320	0.442
2	Pathalam Bridge	0.075	617143	360	0.222	1120	0.691
3	Aluva Thoittumugham	0.6	5456842	160	0.873	480	2.619
4	Shanti Lotous	No discharge through Drain (Dry)					
5	Asramam Road	0.05	1944000	280	0.544	880	1.711
6	Aluva Market/Jewel River woods flat	0.10	1024000	420	0.430	1280	1.311
7	Hotel Periyar	0.03	315977	340	0.107	1040	0.329
8	Puthalam Kadavu Drain	0.04	348365	120	0.042	400	0.139
9	Thoombungal Thodu	1.00	6912000	300	2.074	960	6.636
10	Edapally Thodu	1.20	9953280	180	1.792	560	5.574

## Major Drains Identified: location details



#### 4. ACTION PLAN

##### 4.1 SHORT TERM MEASURES

TABLE 3.2

Sl No	Ref para no:48 as per NGT Order no.673/2018 dated 20.09.2018	Activity	Implementing agency	Cost Rs.	Source of fund	Time line	Expected outcome
1	A(b)	Augmentation and Revamping of existing STP at near Adwaitha Ashramam and to increase the capacity of STP so as to treat more sewage generated in the municipality	Aluva Municipality	6 Lakhs	Source of fund to be reported by Aluva Municipality	Dec 2019	Reduces the pollution load at Periyar River
2	A(b)	Augmentation and Revamping of existing STP at Aluva Market and to increase the capacity of STP so as to treat more sewage generated in the municipality	Aluva Municipality	15 Lakhs	Plan	2021	Reduces the pollution load at Periyar River
3	A(b)	Discharge of sewage from township to the River through drain near Periyar Hotel shall be stopped.	Aluva Municipality	5 Lakhs	Source of fund to be reported by Aluva Municipality	2020	To prevent the sewage discharging to drains
4	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain and to collect fine based on polluter pay principle	Aluva Municipality KSPCB	2 Lakh	Source of fund to be reported by Aluva Municipality	2020	Survey need to conducted and action shall be initiated
5	A(a)(iv)	Periodical inspection in the Industries, Flats, hotels monitoring of STP,ETP.	KSPCB	2 lakhs	Own fund	Periodical	The STP/ETP shall be monitored to assess the efficiency
6	C(ii)	Installation of modern abattoirs.	Aluva Municipality	2 Cr	Plan	March 2021	The unauthorized

							slaughtering with proper waste disposal system can be controlled.
7	A(b)	Procurement of sewer cleaning machines and equipment maintenance	Aluva Municipality	40 Lakhs	Plan	March 2020	The sewers shall be cleaned and maintained properly in order to avoid block, mosquito breeding etc
8	E	Installation of cameras at the waste dumping spots	Aluva Municipality	5 lakhs	plan	2020	The waste dumping practices can be minimized.
9	A(b)	Construction of retaining wall with HDPE liner at Kalamassery dumping yard in order to prevent the leachate discharge from the yard to Thoombungal Thodu	Kalamassery Municipality	1.40 Cr	Plan	Sept 2019	Reduces the pollution load at Thoombungal thodu. Prevent leaching from dumping yard to thoombungal thodu. Construction work of retaining wall progressing
10	C(ii)	Installation of plastic shredding unit	Kalamassery Municipality	1 Cr	Plan	June 2019	
11	A(a)(iv)	Constitution of squads for night surveillance for finding the unauthorized dumping of	Kalamassery Municipality	1 Lakhs	Plan	2020	Prevents unauthorized dumping

		sewage at NAD wet lands Kalamassery	Police department				of septage which reaches the thombungal thodu
12	A(b)	Installation of common STP for Kalamassery Municipality and ETP at Municipal Market	Kalamassery Municipality	25 Lakhs	Plan	December 2019	Stops the discharge to the drain which joins at Puthalamkadavu
13	A(a)(iv)	Monitoring and surveillance of industries in Kalamassery Industrial Estate in order to prevent unauthorized discharges to Muttar River	KSPCB	5 Lakhs Own fund	Plan	2019	Unauthorized discharges can be controlled.
14	C(ii)	Installation of modern abattoirs including poultry and meat rendering plants.	Kalamassery Municipality  Industries Department (for land allotment)	30 Lakhs	Plan	2021	The unauthorized slaughtering with proper waste disposal system can be controlled. Land may be allotted from KINFRA or From HMT
15	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain.	Kalamassery Municipality	2 Lakhs	Own fund	2020	Detailed Survey to be conducted
16	E	Installation of cameras at the waste dumping spots	Kalamassery Municipality	5 lakhs	Own fund	2020	The waste dumping practices can be minimized.



17	A(b)	Identification of sources of sewage discharged to drain near Pathalam bridge and action to stop the discharge which reach river Periyar from hotels, labour camps etc In case the quantity of sewage generated is assessed to be more STP need to be installed	Eloor Municipality  KSPCB (for monitoring)	2 Lakhs for study  15 Lkajs for STP	Own fund	2020	Detailed Survey to be conducted
18	E	Installation of cameras at the waste dumping spots	Eloor Municipality	5 lakhs	Own fund	2020	The waste dumping practices can be minimized.
19	A(a)(iv)	Periodical inspection in the Industries, Flats, hotels for monitoring of STP,ETP located in Cochin corporation.	KSPCB	1 Lakh	Own fund	In progress	To assess the efficiency of STP and to prevent unauthorized discharge
20	A(a)	Inventory of sources of pollution through a rapid study/Study for identification of pollution sources at Edapally thodu	Cochin Municipal Corporation	3 Lakh	Plan fund	3 months	Can Identify the sources of sewage discharged to thodu ultimately reaching at River Periyar at downstream of Manjummal bund
21	E	issuing notice to the defaulters	Cochin Municipal Corporation	-	Own fund	4 months	To warn the defaulters and to direct them to make alternative arrangements for

							disposal of the waste including construction of treatment plants.
22	A(a)(iv)	Periodical inspection in the flats, hotels, shops located along the river	Cochin Municipal Corporation	-	Own fund	Periodical	Prevent illegal dumping and unauthorized discharges
23	A(b)	Identification of natural drains/thodu reaching river Periyar and cleaning of weeds, grasses etc	Irrigation department	5 Cr	plan fund	2 years	River flow can be maintained and also prevent encroachment.
24	C(iii)	Clearing of weeds, grasses at the river bank in order to ensure the smooth flow of water	Irrigation department	2 Cr	plan fund	3 years	River flow can be maintained and also encroachments can be prevented
25	D(a)	Maintaining of Minimum flow in river during lean period and periodical operation of Regulators at River in-order to maintain minimum flow.	Irrigation department	25 Lakhs	plan fund	3 years	To avoid stagnation of water and prevents algal bloom and fish death
26	A(b)	Common Effluent Treatment Plant at Edayar Industrial Estate	Industries department	3 Cr	Plan	2022	All small scale industries can treat their effluent in common ETP and in turn helps in

							water pollution control. The existing proposal for the CETP of industries department was withdrawn due to public protest.
27	A(b)	Construction of internal roads and proper drainage in Edayar industrial estate	Industries department	5 Cr	Plan	Work progressing	No proper storm water drains provided in the industrial belt. Proper drainage helps to segregate the storm water and prevent stagnation and water logging
28	A(b)	Installation of common discharge pipe line at downstream of Pathalam Regulator Bridge	Industries department Irrigation department	3.0Cr 50 lakhs	plan fund	3 Years	Discharge of all industrial treated effluent at downstream of pathalam regulator Bridge (estuary) helps to improve the water quality at upstream

							area.
29	E	Installation of Night vision surveillance cameras at the River Bank side	KSPCB	2Cr	Plan Fund	2020	At present 9 cameras already installed by PCB at River side. Installation of more cameras helps ineffective surveillance of industries
30	A(a)(iv)	Periodical Monitoring of Eloor, Edayar, Kalamassery Industrial belts	KSPCB	5 lakhs (purchase of portable water analyzers , Boat)	Plan Fund	2020	Control water pollution due to industrial discharge
31	A(a)(iv)	Monitoring of quality of water at various intake point	Kerala Water Authority	2 Lakhs(purchase of water analyzers )	Own fund	2020	Ensure the quality of treated water supplied to the communities
32	A(a)(iv)	Installation of additional continuous online River water monitoring station	KSPCB	2 Cr	Plan Fund	2022	At present one station installed at downstream of Periyar. Additional facility can be provided. Helps to monitor the river water quality. Data will be connected

							to the server and can be shared in public domain.
33	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain	Kadungallur Panchayath	2 Lakhs	Plan	2020	Detailed Survey to be conducted
34	E	Installation of cameras at the waste dumping spots	Kadungallur Panchayath	5 lakhs	Own fund	2020	The waste dumping practices can be minimized.
35	A(b)	Identification of the establishments/commercial complexes/flats/houses/hotels etc who is discharging the sewage to the public drain	Choornikkara Panchayath	2 Lakhs	Plan	2020	Detailed Survey to be conducted
36	E	Installation of cameras at the waste dumping spots	Choornikkara Panchayath	5 lakhs	Plan	2020	The waste dumping practices can be minimized.

**4.2 LONG TERM MEASURES**

**TABLE 3.4**

Sl No	Ref para no :48as per NGT Order no.673/2018 dated 20.09.2018	Activity	Implementing agency	Cost Rs. Cr	Source of fund	Time line	Expected outcome
1	A(b)	Construction of walkway, ring roads etc at the Periyar River bank at industrial belt.	Irrigation department	20 Cr	plan fund	4 years	Helps in monitoring of industries and can easily find any un authorized discharge from industries
2	C(i)	Fencing of the river banks along the stretches of waste disposal (Edamula stretch)	Cochin Municipal Corporation	1 Lakh	Plan fund	1-2 years	Throwing of waste materials into the river bodies can be prevented by this
3	C(iii)	Beautification of the river stretches (Edamula stretch)	Cochin Municipal Corporation	1 Lakh	CSR funds	1-2 years	Improve aesthetic appearance

### 4.3 ACTION PLAN BY GROUND WATER DEPARTMENT

Sl.No	Ref para no:48as per NGT Order no.673/2018 dated 20.09.2018	Activity	Ground Water Department
1	B(i)	Ground Water resources and regulation of ground water extraction by industries particularly in over exploited as critical zones/blocks	As per Groundwater resources of Kerala, 2017 estimate a total number of 4 blocks (Alangad, Paravoor, Parakkadavu, and Vypin) comes under the Periyar river basin. All the blocks in the river stretch except Parakkadavu block are safe with stage of groundwater extraction ranges from 46.26% to 79.12%
2	B(ii)	Ground water recharging / rain water harvesting	The average pre-monsoon groundwater level of the blocks ranges from 1.465 - 4.43 mbgl. Since the area falls in the coastal sedimentary belt, groundwater recharge is not possible.
3	B(iii)	Periodic ground waste quality assessment and remedial actions in case of contaminated ground water tube wells/bore wells or hand pumps	Groundwater Department has 2 observation dug wells in this river stretch.
4	B(iv)	For regulating use of ground water for irrigation purpose, adopting good irrigation practices	The total irrigation draft in the area ranges from 53.64 - 1008 ha.m.

# PHOTOGRAPHS

## 1.District Level Technical Committee (DLTC) first Meeting on 20.05.2019



**PHOTO 1 .1**



**PHOTO 1.2**



**PHOTO 1.3.**





**PHOTO 2.1**



**PHOTO 2.2**

**2.Committee visiting drains at Aluva Municipality STP**



**PHOTO 3.1 &3.2**

**3.Visit at Aluva Market**



**PHOTO 4.1**



**PHOTO 4.2**

**4. Committee visiting drains at wet land at NAD, Kalamssery, Kalamssery dumping yard**



**5. Committee visit at Edayar Industrial Area- Pathalam Regulator cum Bridge**