REPORT ON RESTORATION OF POLLUTED RIVER STRETCHES DRAFT ACTION PLAN KALLAYI RIVER Priority-(V)

SUBMITTED BY

KOZHIKODE DISTRICT LEVEL TECHNICAL COMMITTEE

JUNE 2019

Contents

ACTION PLAN OF KALLAI RIVER

Executive Summary

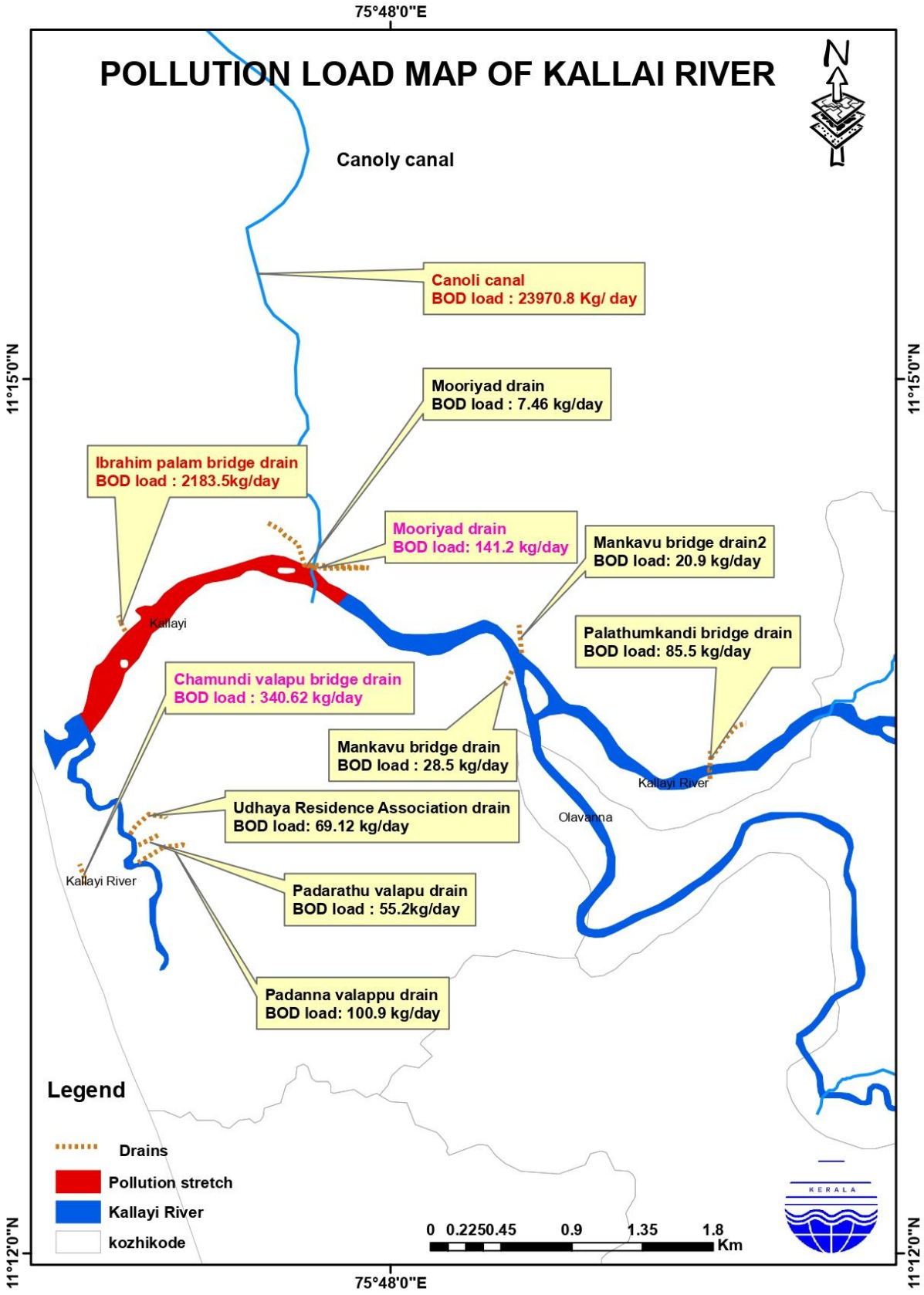
The draft action plan of Kallai River was submitted before Hon'ble NGT earlier on 15-12-2019. The modified action plan is given below.

Kallayi River is a river flowing in the southern state of India, Kerala. Kallayi River is one of the smallest rivers in the State. The river rises in the Western Ghats of Cherikkulathur village in Kozhikode District at a height of 45m. It is linked to the Chaliyar River by an artificial canal on the south side of the small timber village of Kallayi, which is situated on the bank of the river. The river flows through Cherikkulathur, Kovur, Olavanna, Mankavu, Kallayi, Pallikkandi and Kothi and ultimately evacuates in the Arabian Sea at Kozhikode. The river basin is located in the Kozhikode district. The river is 22km in length and is spread over an area of 96 sqkm.

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

Sl. No	NAME OF DRAIN	WIDTH (meter)	WATER DEPTH OF DRAIN (meter)		AREA (m^2)	VELOCITY (m/s)	DISCHARGE (m^3/s)	BOD (mg/L)	BOD LOAD (kg/day)
			present depth of water	maximum depth of drain					
1	Palathumkandi Bridge	0.5	0.09	0.55	0.045	0.125	0.005625	220	106.92
2	Mankavu Bridge-1	0.5	0.15	0.5	0.075	0.025	0.001875	220	35.64

3	Mankavu Bridge-2	0.7	0.05	0.9	0.035	0.108	0.00378	80	26.13
4	Ibrahim palam Bridge	4.5	0.3	1.6	1.35	0.09	0.1215	260	2729.38
5	ChamundiValapu Bridge	11	0.2	0.9	2.2	0.028	0.0616	80	425.78
6	Padannavalapu	3.6	0.12	1.1	0.432	0.013	0.005616	260	126.16
7	Padarathuvalapu	4	0.2	0.7	0.8	0.01	0.008	80	55.30
8	Udhaya Residence Association	6.5	0.25	0.7	1.625	0.01	0.01625	100	140.40
9	Mooriyad - 1	0.3	0.1	1	0.03	0.018	0.00054	200	9.3312
10	Mooriyad - 2	4.7	0.23	1.6	1.081	0.021	0.022701	90	176.52
11	Puthiyapalambridge (Canoli Canal	17	1.5	2.5	25.5	0.05	1.275	170	18727.20


POLLUTION LOAD MAP OF KALLAI RIVER
75°48'0"E
11°15'0"N
11°12'0"N
N
Canoly canal
Canoli canal
BOD load : 23970.8 Kg/ day
Mooriyad drain
BOD load : 7.46 kg/day
Ibrahim palam bridge drain
BOD load : 2183.5kg/day
Mooriyad drain
BOD load: 141.2 kg/day
Mankavu bridge drain2
BOD load: 20.9 kg/day
Kallayi
Palathumkandi bridge drain
BOD load: 85.5 kg/day
Chamundi valapu bridge drain
BOD load : 340.62 kg/day
Mankavu bridge drain
BOD load : 28.5 kg/day
Kallayi River
Udhaya Residence Association drain
BOD load: 69.12 kg/day
Olavanna
Kallayi River
Padarathu valapu drain
BOD load : 55.2kg/day
Padanna valappu drain
BOD load: 100.9 kg/day
Legend
Drains
Pollution stretch
Kallayi River
kozhikode
0 0.2250.45 0.9 1.35 1.8
Km
KERALA

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:

Sl. no	Action proposed	Action taken	Implementing agency	Estimated Expenditure	Funding agency	Time limit	Expected outcome
1	Identification of illegal outlets into storm water drain and issue Notice to such units	Issued notice to 92 units. 3o units installed waste water disposal facility in their unit	Corporation	Not needed	-	30.12.2020	Reduced pollution load in drains
2	Waste to energy project proposed at Njeliyamparamba	Approved and Tender accepted	KSIDC	250 Crore	D.B.F.O.T	30.06.2021	Reduced dumping of solid wastes in river and public places
3	Establishment of Aerobic compost units	24 units established in 6 sites 3.1 Tagore Hall(2 no.) 3.2 S.K pottakkad hall 3.3 Jubilee hall 3.4 Mofusil bus stand 3.5 T.B clinic 3.6 Circle office	Corporation	25 lakhs	Own fund	Completed and functioning	Reduced dumping of solid wastes
4	Seggregation of solid wste at source level and treatment of house hold wastes	300 ring compost and 150 biogas plant installed	Corporation	2.5 crore	Own fund	30.06.2019	Reduced dumping of house hold wastes into drains

5	Setting up of rendering treatment plant for chicken stall wastes	Installed in Thamarasseryp anchayath. Now waste is collected from 170 units	Fresh cut agency	12 crore	Private investmen t	on trial run	Reduced dumping of wastes on the banks of river
6	Implementation of Green protocol unit	Purchased 750 steel plates and steel glasses	Corporation	9 lakhs	Own fund	31.06.2019	Reduced use of plastic
7	Setting up of common STP of(13 MLD)		Corporation	Total- 116.5 crore	Central/sta te Govt./mun icipality combined project	31.03.2020	Entire polluted river stretch identified by CPCB will be free from effluent discharge to public drain
		7.1 At Kothi bridge- 6 MLD plant proposed		56.63 crore			
		7.2 At Avikkal -7 MLD plant proposed		59.87 crore			
8	Cleaning of Canoli canal	Combined cleaning with public and Government	Corporation	46 lakhs	C.S.R fund(KWI L) and Suchitwa Mission	20.07.2019	Reduced pollution load in canoli canal
9	Purchasing of Solar Boat for Canoli canal cleaning	D.P.C approved the project	Corporation	30 lakhs	Own fund	31.03.2020	Reduced pollution load in canoli canal
10	Installation of CCTV Camera for the Identification and monitoring of illegal activities	D.P.C approved the project. Contacted Keltron	Corporation	30 lakhs	Own fund	31.03.2020	Reduced dumping of wastes in to river, road side.
11	Establishment of Mobile Septage Units	D.P.C approved the project	Corporation	50 lakhs	Own fund	31.03.2020	Reduction of pollution load in river
12	Action taken against dumping of wastes into river and public places	fine RS. 32 lakh imposed	Corporation	-	-	Continuing	Reduction of dumping of wastes in public places

13	Cleaning of B.K canal	Cleaning of canal reaches to kallayi river	Corporation	2.88 crore	Central/state Govt./municipality combined project	31.03.2020	Reduced pollution load in B.K canal leading to kallayi
14	Establishment of treatment plant at Medical college (3 MLD plant)	Tender over 14.1 -2 MLD plant proposed 14.2- 1 MLD plant proposed	Corporation	14.10 crore	Central/state Govt./municipality combined project	31.03.2020	Reduction in pollution load at canoli canal
15	Construction of drains at Y.M.RC Ayyankar colony	Tendering process in progress	Corporation	14.10 crore	Central/state Govt./municipality combined project	31.03.2020	To prevent pollution load in drain leading kallayi
16	Implementation of STP at Kottooli (13.5 MLD)	Hon'ble NGT stayed the project (NGT case no: 215/2016(SZ)	Corporation	90.04 crore	K.S.U.D.P fund (No fund available at present)		Reduction of pollution load in canoli canal. Drains from mavoor road, karaparamb, sarovaram leading to canoli canal will be free from effluent discharge to public drain
17	Treatment facility for waste water in Central market	Tendering process in progress	Corporation	50 lakhs	Own fund	-	Reduction of waste water entering into drains
18	Establishment of comfort stations	Tender accepted	Corporation	90 lakhs	Own fund		Reduction in pollution load to drain
19	Provide facility for MRF,RRF, Super MRF	3 units existing 19.1 Njeliyanparamb 19.2 Industrial estate 19.3 Meyorbhavanjayanthinagar colony	Suchitwa Mission	1.58 crore	Suchitwa Mission fund	Project in progress	Reduced disposal of solid-waste

20	Identification of illegal outlets from house to storm water drain and issue Notice to such Houses	Action in progress as decided in the DLTC	Corporation	-	-	-	Reduced disposal of domestic effluents in to drains
21	Establishment of Plastic shredding unit		Corporation	75 lakhs	Own fund	Project started	Reduce dumping of plastic in public places
22	Establishment of slaughtering unit	Submitted DPR	Corporation	10.5 crore	Submitted to KIFBI		Reduce dumping of slaughter house wastes
23	Cleaning of drains in Kozhikode Town	With the help of Health inspectors and ULCC actions carried on	Corporation	1.68 crore	Own fund andSuchitwa Mission	Ongoing	Reduce pollution loads in drain

Sl. no	Action proposed	Action taken	Implementing agency	Estimated Expenditure	Funding agency	Time limit	Expected outcome
24.	Desilting of Kallayi river from Kaduppini to Kothi in Kozhikode Corporation	Proposal submitted under RMF	Irrigation department	7 crore	Revenue Department	31.03.2021	To retain the flow of the river
25.	Provide fencing on the sides of the Bridge		Irrigation department	Total 42 lakhs	Revenue non plan	31.03.2021	To reduce the dumping of wastes into river
26.		3.1 Providing Fencing on Puthiyapalam Bridge across EK canal		6.20 lakhs			

		3.2 Providing Fencing on Mooriyad Road Bridge		7.60 lakhs			
		3.3 Providing Fencing on both sides of Chamundi Bridge		3.60 lakhs			
		3.4 Providing Fencing on both sides of Kothi Bridge		23 lakhs			
		3.5 Providing Fencing on both sides of Ibrahim Bridge		1.60 lakhs			
27	Dredging, Desilting & removal of weeds from E K Canal (11.2 km)	Work entrusted to Kerala Water Ways & Infrastructure Ltd(KWIL)	KWIL	46 lakhs	CSIND	31.07.2019	To ensure free flow in the canal. Removal of silt from the canal mouth near Kallai River is also part of this work.

	Activity	**Cost**	**Source of fund**	**Time line**	**Remarks**
28.	River water quality monitoring- Kallayi river	-	National Water Quality Monitoring Programme (NWMP), CPCB fund	Ongoing; monthly frequency	-

29.	River water quality monitoring – Kallayi rivers	-	State Water Monitoring Programme, KSPCB fund (SWMP), KSPCB fund	Ongoing. Seasonal monitoring– pre-monsoon, monsoon, post-monsoon	-
30	Inspection and effluent quality monitoring of the flats, industrial units, service stations, hospitals, hotels etc . in Malappuram Municipal area	-	KSPCB funds	Ongoing Interval: Red–1month. Orange – 3 months. Green – 6 months.	-

	Activity	**Cost**	**Source of fund**	**Time line**	**Remarks**
31	Board displaying messages against dumping to be placed in river banks	RS. 25000/-	Suchitwa mission	15.07.2019	Reduction in pollution loads to drain

Action Plan by Ground Water Department

Sl.No	**Ref para No 48 as per NGT Order no 673/2018 dated20.9.2018**	Activity	Ground Water Department
1	B(i)	Ground Water resources and regulation of ground	As per Groundwater resources of Kerala, 2017 estimate ,Kozhikkode Block comes under the Kallai river basin and the block is

		water extraction by industries particularly in over expolited as critical zones/blocks	safe with stage of groundwater extraction 68.49%
2	B(ii)	Ground water recharging / rain water harvesting	The average pre-monsoon groundwater level is 7.23mbgl. Groundwater Department has implemeted 3 no of dug well recharge schemes at Kozhikkode block
3	B(iii)	Periodic ground waste quality assessment and remedial actions in case of con taminated ground water tube wells/bore wells or hand pumps	Groundwater Department has 1 observation piezometer (BW)in the river stretch.
4	B(iv)	For regulating use of ground water for irrigation purpose, adopting good irrigation practices	The total irrigation draft in the block area is 488.76 ha.m.

Action plan by irrigation Department

Sl.No	**Ref para No 48 as per NGT Order no 673/2018 dated20.9.2018**	Activity	Department	Cost	Timeline
1.	E	Dredging and	Irrigation	KWIL	3 years

		desilting			
2.	E	E-flow (by micro water shed management)	Irrigation	1cr	3 years
3.	E	Flood plane zone (protection and management)	Irrigation	1cr	3 years
4.	E	Grenary development (plant in trees on the banks)	Irrigation	2cr	3 years

Specific Remarks

1. As per item no.7 of the action plan proposed by Kozhikode corporation, a common sewage treatment plant of 6 MLD plant is proposed at Kothi area. If this STP is commissioned, the entire sewage and sullage coming from the Payyanakkal area in the stretch Thekkeppuram to Arakkinar identified by CPCB as polluted drain stretch can be treated and the storm water drain and river Kallayi will be free from the pollution load coming from the residential areas.
2. As per the item no.16 of the action plan proposed by Kozhikode corporation, a Sewage treatment plant of 13.5 MLD capacity was proposed at Kottooli which was proposed by Kerala State Urban Development Project. The STP proposal included advanced and widely accepted treatment technology namely Sequential Batch Reactor. The Integrated Consent to Establish of the KSPCB was issued for the proposed STP. But the application no.215/2016 of the Hon'ble National Green Tribunal was existing and as the proposal was on stay as orderd by the NGT in the above case, the proposed STP has not yet set up. About 12% of sewer lines has been already laid by Kerala Water Authority If the

S.T.P gets into operation, the major sources of effluent reaching the Canoli canal from Mavoor road, Karaparamb, Sarovaram which is having the highest pollution load will be treated in the STP and there by the sources of storm water drains reaching the Canoli canal will be free from effluent discharge and which can be a major solution for reduction of pollution load in the polluted river stretch . Therefore the DLTC committee requests the NGT to kindly wave the stay order in application no.215/2016 and kindly permit for the installation of common sewage treatment plant at Kottooli.

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&
Superintending Engineer
Irrigation Department, Kozhikode

Convener, D.L.T.C
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District Office, Kozhikode

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Superintending Engineer
Kerala Water Authority , Kozhikode

Member, D.L.T.C
&
District Coordinator
District Suchitwa Mission

Member, D.L.T.C
&
General Manager
Industries Department , Kozhikode

Member, D.L.T.C
&
Senior Officer nominated by
District Collector, Revenue Department

Member, D.L.T.C
&
Secretary
Kozhikode Corporation

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The quest of man to conquer nature had led to cover increasing degradation of the environment than envisaged. Scientists and environmentalists now appear to be strongly committed in finding long term solutions to these vexing environmental and resource problems. The far reaching consequence of the problem can only be solved by making the people environmental conscious and thereby achieving a transition into a sustainable society. Rapid rate of urbanization has improved great strain on man and ecosystem. Population explosion compounded with pollution from anthropogenic activities has affected aquatic and terrestrial ecosystem, threatening human life and generating massive economic loss. Thus multifaceted activities like rapid industrialization, expanding population and agricultural activities have severely affected the aquatic ecosystem of Kerala.

Water is one of the abundantly available substances in nature. It covers about 70 to 75% of earth crust. It is one of the most important commodities that have been exploited by man than any other natural resources. This is because water is one of the prime necessities of life since its development in earth. Water is distributed in nature in different forms such as rain water, river water, spring water, sea water, glaciers etc. Rain water is the purest form of naturally occurring water. Most of the demands of water of mankind are fulfilled by rain water, which gets deposited in earth surface as ground water resource.

The total quantity of water on earth remains constant, with the endless movement from soil to atmosphere and back through the hydrologic cycle controlled by two natural processes viz. evaporation and precipitation. As the quantity of water remains the same, we reuse it and hence it becomes easily polluted. Out of the total quantity of water available in the universe only 3% is only fresh water and the remaining saline water. Of the total fresh water quantity 70% are in the form of glaciers, ice caps etc, 20% as ground water 6% in the form of surface water and

4% various other sources. Thus from the above data it is clear that only 0.1% of the total water balance is considered as fresh water and is available for drinking purpose.

Water is the most important natural resource not only of a state or a country, but of the entire humanity. The prosperity of a nation depends primarily upon the judicious exploitation of this resource. Thus, it can be stated that the primary wealth of a nation is water, which flows in rivers and streams. This itself establishes the importance of rivers, and no other explanation is required to stress their importance. River basin, as a domain for planning and management has been accepted the world over, as water does not recognize political boundaries. Among the most distinctive features of India are its rivers which hold high religious importance among its people. Covering the vast geographical area of 329 million hectares, Indian rivers have been an important reason for the rural prosperity of India. Being of wider importance in cultural, economical, geographical as well as religious development, its numerous rivers are of great value to India. The rivers in India are considered as Gods and Goddesses, and are even worshiped by the Hindus. They provide tourists a wonderful insight into the historical, cultural and traditional aspects of India. Among various types of inland fresh water bodies, the riverine system is a unique type of ecosystem. The size of the drainage basin, the amount of water moving through the system, the proportion of natural versus settled areas, and man's direct impacts are all key factors determining the quality and characteristics of each watershed

1.2 NEED FOR THE STUDY

Water quality problems in India the shortage of water in the country has started affecting the lives of people as well as the Environment around them. Some of the major issues that need urgent attention are: As a result of excessive extraction of ground water to meet agriculture, industrial and domestic demands, drinking water is not available during the critical summer months in many parts of the country. About 10 per cent of the rural and urban populations do not have access to regular safe drinking water and many more are threatened. Most of them depend on unsafe water Sources to meet their daily needs. Moreover, water shortages in cities and villages have led to large volumes of water being collected and transported over great distances by tankers and pipelines.

With over extraction of groundwater the concentration of dissolved constituents/ionic concentrations is increasing regularly. Ingress of seawater into coastal aquifers as a result of over extraction of ground water has made water supplies more saline, unsuitable for drinking and irrigation. Pollution of surface and groundwater from agro-chemicals (Fertilizers and Pesticides) and from industry poses a major environmental health hazard, with potentially significant costs to the country. In recent times, the demand for water has increased many folds due to increased domestic and industrial needs. The development of water resources in a river basin is not a goal by itself, but a means to reach the socio-economic objectives of production, income, employment and quality of life. Therefore, water resources development should be considered in the wider context of regional planning. Such a plan needs a systematic study in the basin to know the spatial distribution of water quality so that any sustainable approach could be implemented in the river basin. Thus, in order to meet society's need for water, preventive measures must be taken to ensure the sustainability of the water resources.

A general statistical study and analysis on the bio-physico and chemical parameters of the basin's surface water quality have been carried out to find the interrelationship among them and also to know the water quality trends in the basin. The management of river water quality is a major environmental challenge. Monitoring different sources of pollutant load contribution to the river basin is quite a difficult, laborious and expensive process which sometimes leads to analytical errors also. The main objective of the present study is to provide an overview of the water quality of the **Kallayi River** and if needed, to develop an action plan to boost up the water quality of the polluted river stretches identified.

1.3 GENERAL PHYSIOGRAPHY OF KOZHIODE DISTRICT.

Topographically the district has three distinct regions - the sandy coastal region including sand bars and marshes, the rocky highlands formed by the hilly portion of the Western Ghats and lateritic midland with undulating topography. From the total area of 2344 sq.kms, the sandy coastal belt contributes about 15.5 per cent, lateritic midlands about 57.3 per cent and rocky highlands about 27.2 per cent.

The District of Kozhikode comprises of three taluks viz. Kozhikode, Vadakara and Quilandy which are subdivided into 12 blocks and 77 panchayats.The Headquarters of the district, viz. Kozhikode city is one among the three city corporations in the state. Kozhikode coast is 72.5 km.

long and it stretches from Kadalundikadavu in south to Aliyur in the north near Mahi covering an area of 91 sq.km excluding the backwater areas (Fig. 2.1). This area is bounded between the sea and the laterite formations. Vadakara, QuiIandy, Kozhikode, Beypore and Kadalundi are some of the important towns in the coastal tract.

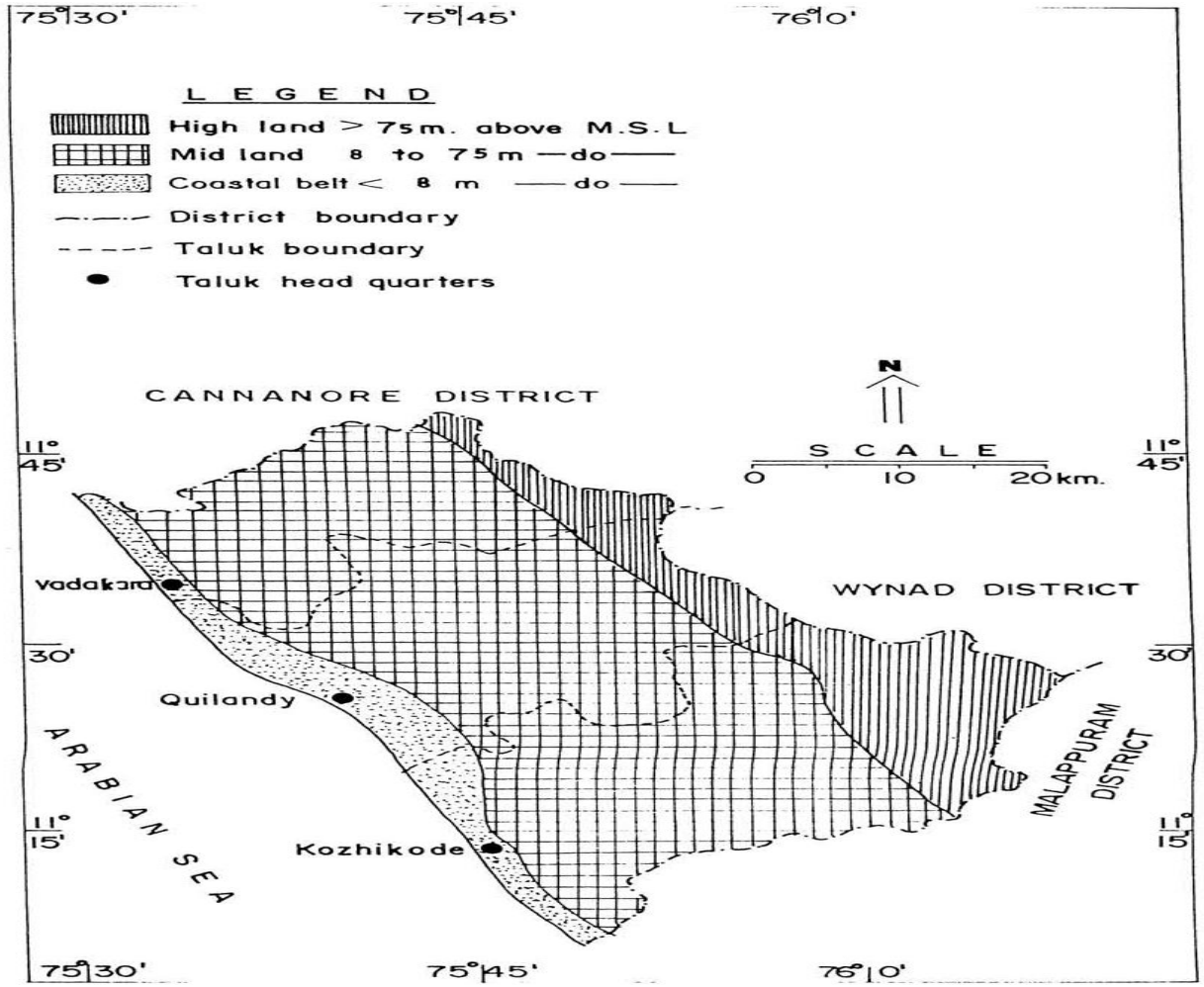

FIG. 2.1 MAP OF KOZHIKODE DISTRICT IN KERALA STATE

Fig. 1. Map of Kozhikode district

1.4. CLIMATE AND METEREOLOGY

The district has a generally tropical humid climate with a very hot season extending from March to May and wet season or rainy season from June to September, October to November & December to January. Humidity is very high all along the coastal region. According to the

Koppen's climate classification it comes under tropical monsoon climate. During December to march, practically no rain is received, and from October onwards the temperature gradually increases to reach the maximum in May, which is the hottest month of the year. The highest maximum temperature recorded at Kozhikode was 39.4 °C during the month of March 1975 and lowest temperature was 14 °C recorded on 26th December 1975. The hot season extends from March to May without rain except a short spell of pre-monsoon Mango Showers.

The rainy season is the South West Monsoon, which sets in the first week of June and extends up to September and the rain receives from the south west monsoon which accounts for about 62% of rainfall received by the region. . The North East Monsoon extends from the second half of October through November. It accounts for 14% of rainfall and the rest of rain fall occur in winter season from December to January. The average annual rainfall is 3,266 mm. Winters are seldom cold and skies are clear and air is crisp. The nearness to sea not allows much variation in temperature and the average temperature is about 28^{o}c.The highest temperature ever recorded in the area was 39.4^{o}c in March 1975. The lowest was 14^{o}c recorded on 26 December 1975.

1.5. GENERAL LAND USE PATTERN AND POPULATION

The latest data on land use pattern in Kozhikode district is given below (Kerala state Land Use Board 2010)

Table 1.Land use pattern in Kozhikode district

TYPE OF LAND	**AREA IN HECTARES**
Total geographical area	2,33,330
Forest	41,386
Land put to non-agricultural use	16,351
Barren and uncultivable land	2262
Permanent pastures and grazing land	122
Land under miscellaneous tree crops	2652
Cultivable waste	2288
Fallow (other than current fallow)	1293
Current fallow	2282

Net area sown	1,64,694
Area sown more than once	35,060
Total cropped area	19,954

Being thickly populated, a substantial portion of Kozhikode coastal belt is utilized for residential purposes and in the remaining areas, the crops grown are coconut, tapioca, banana and vegetables.

According to the 2011 census Kozhikode district have a population of 3,089,543, and population density of 1,318 inhabitants per square kilometer, sex ratio of 1097, and literacy rate of 95.24%. Its population growth rate over the decade 2001-2011 was 7.31 %.

1.6. GENERAL GEOLOGY AND SOIL CHARACTERISTICS.

A general geological map of Kozhikode Corporation is prepared based on the available maps of geological survey of India [GSI].The coastal region of the area is bounded between sea and laterite formations.The geological feature of this coastal belt mainly consists of sand dunes, sand stones and clays.According to the soil survey report of Department of Agriculture (1978), Kozhikode District has basically six types of soils e.g. coastal alluvium,riverinealluvium, brown hydramorphic laterites, forest loam and grayish onattukara.

Spatial Distribution of Soils in Kozhikode District: [Source: Department of Agriculture]

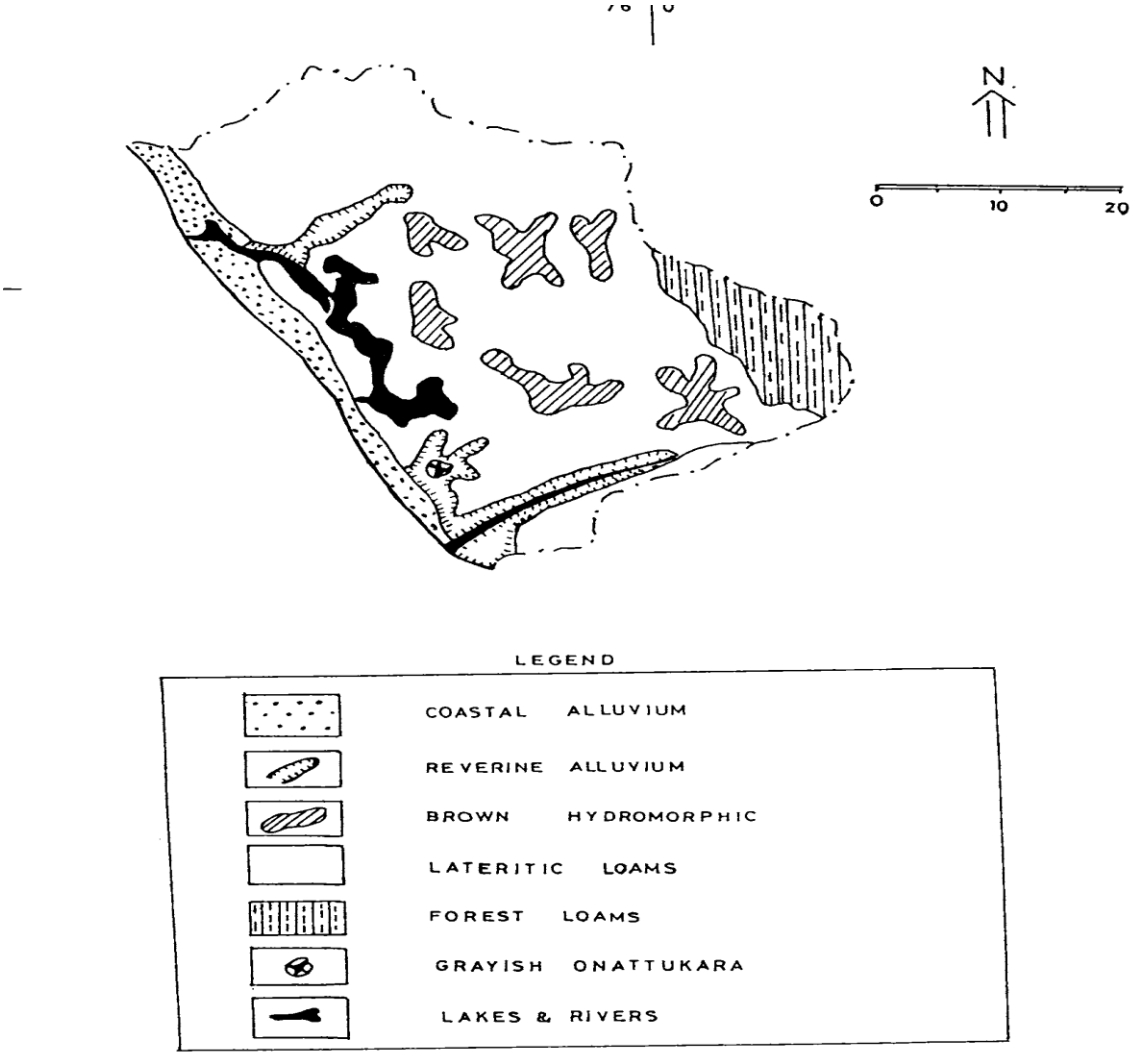

Fig.2. SpatialDistribution of Soils in Kozhikode District

The coastal alluvium is distributed all along the coast. The low clay content and organic matter has been responsible for lowcation exchange capacity. The crops irrigated in it include coconut, tapioca, paddy and fruits.The riverine alluvium composed of moderately well-drained soils distributed mainly on the banks of rivers and tributaries. They occur on flat to gently sloping lands. They are light tomedium textured with good physical properties and good productivity. The usual crops cultivated in it are coconut, arecnut, banana, vegetables and fruits.

1.7. GEO MORPHOLOGY

The shoreline of Kozhikode coast generally is with minor undulations at Kadalur near Quilandy. The shoreline is seen more or less straight from Kadalur to Beypore. The various major geomorphic units identified fram the coastal areas include beach, sand bars, shore platforms, lateritic hills, and valleys. (Ahmed 1973) Naduvattam Panniyankara area in Kozhikode represents a typical sand bar, with small valleys. Paddy is cultivated in these valleys. 19 Two major types of shore-lines are identified in Kozhikode coast, namely cliffed and neutral shoreline (Nair, 1987). In cliffed shoreline the cliffs are bordered by platforms with gentle slopes extending across the shore. These are developed obviously due to cliff recession by wave attack. They extent from high tide level at the base of receding cliffs, to the low tide level ~nthe nearshore zone and are intertidal shore platforms. Such platforms are found developed on laterites around Quilandy west and Aliyur near Mahe. The shoreline between Elathur and Beypore falls under the neutral category. These shorelines are found more or less straight. 20

1.8. RAINFALL AND TEMPERATURE

The coastal area in Kozhikode district enjoys a humid tropical climate with an average rainfall of about 3000 mm, whereas the average rainfall for the whole district is about 3424 mm. Kozhikode coast experiences two monsoons. The southwest monsoon enters the coast in June and lasts till September and is the main cause of rainfall. About 20% to 25% of the annual rainfall is recorded in the month of November and December due to northeast monsoon. The minirnum and maximum temperatures are around 23.5 C and o 34 C.

1.9. RIVERS AND BACKWATERS

Kozhikode District has 4 major rivers. All are west-flowing and drain into Arabian Sea. The largest river is Kuttiyadi River. The major features of the rivers are tabulated below.

Table.2. Characteristics of rivers in Kozhikode

Sl.no	Name of River	Length ,[KM]	Catchment Area [SQ.KM]	Annual discharge [MCM]
1	Kuttiyadi river [Moorad river]	74	583	1224.3
2	Kallayi river	22	96	201.6
3	Chaliyar river	169	2535	5323.5
4	Kadalundi river	130	1099	2307.4

Among the rivers, annual discharge of Kuttiyadi is maximum. Chaliyar is having more catchment areabut 17% only falls in Kozhikode. Kallayi is the only river draining fully in Kozhikode. Kozhikode District has a large backwater body, fanned by the confluence of Agalapuzha with the Poonurpuzha. It meets the sea at Elathur. Based on GTS maps thereal extent of this backwater body of Elathur is about 33.36 sq.km. If 3 m is taken as average16 depth then total water stored in this backwater body works out to be 100.68 MQ1.

1.10. RIVERS IDENTIFIED FOR STUDY BY CPCB IN KOZHIKODE DISTRICT

1.10. A. KALLAYIRIVER

Fig.3. Kallayiriver

1.10. A1. PHYSIOGRAPHY OF THE KALLAYI RIVER BASIN:

Table.3. PHYSIOGRAPHY OF THE KALLAYI PPUZHA BASIN

Basin area, km^2	96
Basin area in Kerala State, km^2	96
Basin area in neighboring State, km^2	Nil
District of Kerala in which basin are located	Kozhikode
Origin of River	Cherikkulathur Elevation. m : 45
Length of main stream, km	22
Main tributaries	Nil
Important raingauge stations marked on the map (with code numbers)	1. Kozhikode
Average annual stream flow, Mm	---
Average annual rainfall, mm	3800
Important discharge stations marked on the map (with code numbers)	
Water requirement for wetland for three crops, Mm^3	2882
Water requirement for gardenland , Mm^3	632
Water requirement for domestic use (2021 AD), Mm^3	631
Water requirement for industrial use (2021 AD), Mm^3	450
Major/medium irrigation projects investigated	
Navigate length of river, km	9.6

Fig.4. Kallayi River

Kallayi River is a river flowing in the southern state of India, Kerala. Kallayi River is one of the smallest rivers in the State. The river rises in the Western Ghats of Cherikkulathur village

in Kozhikode District at a height of 45m. It is linked to the Chaliyar River by an artificial canal on the south side of the small timber village of Kallayi, which is situated on the bank of the river. The river flows through Cherikkulathur, Kovur, Olavanna, Mankavu, Kallayi, Pallikkandi and Kothi and ultimately evacuates in the Arabian Sea at Kozhikode. The river basin is located in the Kozhikode district. The river is 22km in length and is spread over an area of 96 sqkm. The river is commercially very significant. The basin is considered as the ancient place of international trade and was used for inland water transport.

1.10. A2. ACTIVITIES OF RIVER

In the past, the river was the second largest centre of timber business in the world. The Canoli Canal in the north and Beypore-Kallayi Canal in the south are linked to the Kallayi River. The Canoli canal which has a length of 11.5 km connects Kallayi River and Elathur River. This canal was earlier used for bringing timber from Beypore and Nilambur and for inland navigation.

Kallayi River was one of the most important place in the world for Timber Business, during the 19thcentury, famous for its Teak and Rose woods, sourced from the famous Nilambur Forests.(At onetime this was considered to be 2nd largest timber yard in the world) .The major portion of the riverbanks were occupied by the flourishing timber depots and sawmills. Timber logs use to be seen at the length & breadth of this long river. Important feature of this yard was, logs collected from various sources are left to season in the saline water for months and years to get additional strength. Due to the availability of high quality timber, Boat & ship building industry was thriving at a port nearby known as 'Beypore Port'. Boats & Ships made out of wood were in great demand and were exported to different parts of the World. Over a period of time, the timber business has substantially reduced, due to the non- availability & restrictions in cutting of timber and the same has directly affected the ship building industry too. While the timber trading is still in progress at a low level, the river still continue to flow, keeping the history behind and memories of the great past left to the locals.

1.10. A3. KALLAYI TOWN

Kallayi is a small town on the banks of Kallayi River which links with the Chaliyar River on the south by a man-made canal. It is in the Kozhikode district of Kerala in south India and is noted

for timber trading during the late 19th and early 20th centuries. During that period, the Chaliyar River was extensively used as a waterway for carrying timber from the forest areas in and around Nilambur to the various mills in Kallayi near Kozhikode. Rafts made of logs were taken downstream during the monsoon season to Kallayi, where these were sawn to size in the timber mills here and then transported for trade. During this period, Kallayi was one of the most important centers in the world for the timber business. The place was noted for woods of superlative strength and durability like teak, rosewood etc. Towards the second half of the 20th century, the activity declined drastically as tree felling was banned or strictly controlled with a view to stop deforestation. Many have now closed down. Today, only a few timber mills exist in the area.

1.10. A4. GROWTH OF TIMBER INDUSTRY AT KALLAYI RIVER BANKS

The river once supported the growth of timber markets and sawmills in the region. As the saline water of the river provided extra strength to the timber, logs from different regions of the State were left to season in Kallayi for several weeks or even months together. Hence, numerous timber mills dotted the banks and massive cranes lifting the logs were a familiar spectacle. Being the most prominent navigable waterway during the reign of Zamorins, Kallayi was mainly used for transporting timber, hill produces and spices from Nilambur forest to the commercial port of Kozhikode.

1.10. A5. GEOLOGY AND SOIL CHARACTERISTICS OF KALLAYI BASIN

The Kallayi river area chiefly consists of mid land and low land. The coastal region of the area is bounded between sea and laterite formations. The geological feature of this coastal belt mainly consists of sand dunes, sand stones and clays. Geo morphologically the area is a river channel, a bed where a natural body of surface water flows or may flow. Soil characteristics invariably control penetration of surface water in to an aquifer system, and they are directly related to rates of infiltration, percolation and permeability. The study area reveals two main soil classes. Imperfectly drained clay and well drained clay.

Recommendation: Side of the bitumen road should be filled with precast block and not with cast in situ concrete. The bed of the drain should be done with dry rubble masonry so as to penetrate the water to the ground.

1.10. A6. REASONS OF RIVER POLLUTION

The quality of the river water mainly depends on the quality of cations and anions existing in it. Some of the major causes of river water pollution are the following.

1. High rate of sedimentation and debris slides.
2. Salinity intrusion into river along the coastal regions,
3. Lack of flushing and concentration of pollutants, especially in the lower stretches of river.
4. Coastal erosion.
5. Pollution by human industrial activity.ie, by discharging of industrial effluents
6. Discharging Sewage causing contamination,
7. Water logging in command areas.
8. Microbial activities in bio-films in underground.

1.10. A7.INDUSTRIAL AND OTHER POLLUTION SOURCES KALLAYI

As the timber industry faded and sawmills shut down, the land along the river banks were encroached. The legendary Kallayi River that symbolized the civilization of Kozhikode is dying a slow death. The filth accumulated over the years has ruined the serene eco-system of the river. The natural flow of water has also slowed down on account of silting. The acute pollution has

decimated aquatic life in the river. Mangrove vegetation on the riverbanks had also been destroyed in many places.

Waste disposed from butcheries in the area and household garbage is dumped into the river. Infestation of weeds, discharge of untreated effluent into the river, dumping of hospital waste, unprotected embankment and untreated waste from septic tanks are hastening its degeneration. The major pollution problem facing the water body is sewage discharge. The depositing of solid waste from construction sites had led to slow filling of the river. Further, the dumping of animal slaughterhouse waste indiscriminately into the river had decreased the depth and area of the river. A project for restoration of the health of the river and eco-restoration should begin with surveys and investigations to find out the extent of encroachment, mapping of existing mangrove growth and the social life on the river's banks.

1.10. A8. ACTUAL DESIGNATED USE OF THE KALLAI RIVER WATER.

No water is being extracted from the Kallayi River for drinking or sanitation purposes. The river famous among the world for Timber Business, being used since 19th century for timber seasoning and lot of wood industries and saw mills were located on its banks. The major portions of the river bank were occupied by the flourishing timber depots and saw mills. Timber logs use to be seen at the length & breadth of this long river. Important feature of this yard was logs collected from various sources are left to season in the saline water for months and years to get additional strength.

The forests of the South Wayanad and Nilambur produced immense quantities of magnificent timber. The trees after being felled and roughly squared are dragged by the elephants to the nearest road or river to be carried or floated to the depots of the timber merchants on the coast. Road transport required more expensive than floating timbers on the river, because it needed loading and unloading workers. They reached at Kallayi and Beypore and were mainly floated through the Chaliyar River or Beypore River. Comparatively low cost river transportation became the backbone of the wood industries of Calicut. The river is navigable for timber logs from June to January. It is very easy that the largest raft can be managed by a single man.

A feature of the wood industry in this district is the concentration of the units in and around Kallayi. Its localization here is pre-eminently beneficial to the industry as water, rail, and road transport facilities are easily available. Kallayi became the second largest timber yard in the world map. At present though the number is drastically reduced, yet there are a good number of wood industries located in the banks of this river near the Kallayi Bridge. The water being scarcely visible for the thousands of logs floating on its surface. The logs are left in the water until they are sold; and eventually they are exported by sea' and rail to Bombay, madras, Kolar and other parts of India Furniture making also sprung up in this district as a corollary to the establishment of saw mills, firstly appeared on the river banks of Kallayi. The principal raw materials required for furniture making finished timber is easily available, and that too in abundant quality from the neighboring saw mills and timber merchants.

CHAPTER 2

WATER QUALITY OF THE RIVER

2.1. STUDY AREA

The river stretches in Kozhikode district have been identified for study by the Central Pollution Control Board is Kallayippuzha

2.1. A. KALLAYI PPUZHA

A Google map location of the area allotted study by CPCB is shown in figure below.

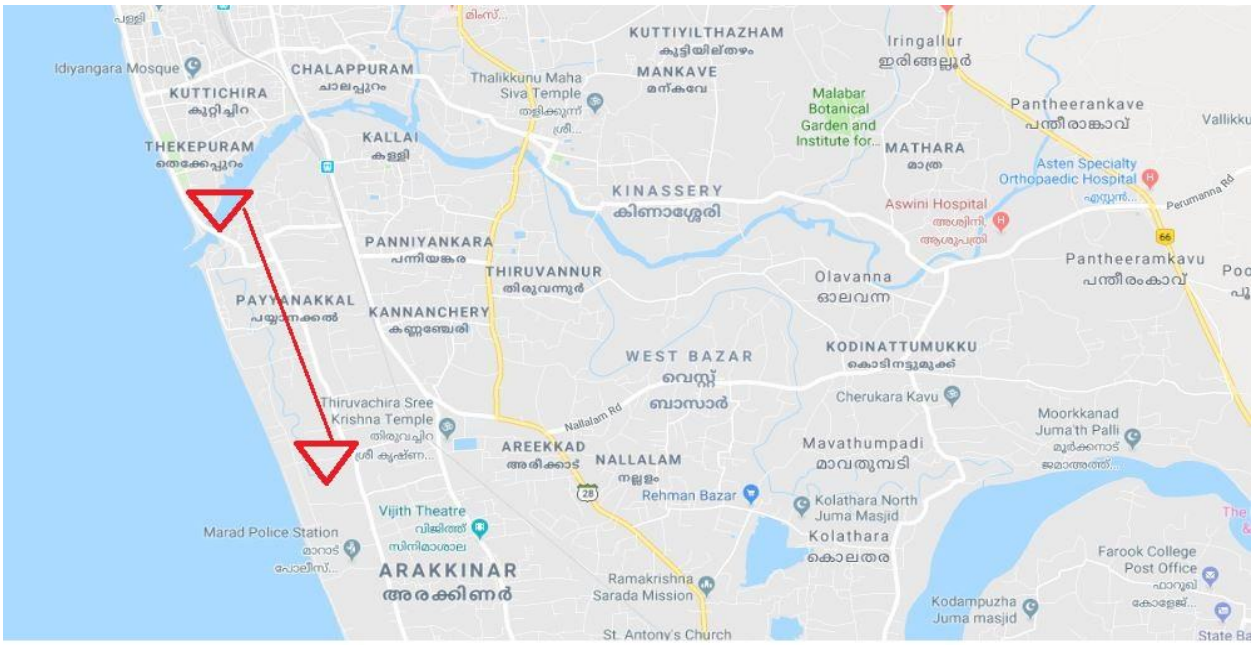

Fig.5. Google map location of the study area

Figure shows the study area allocated by CPCB for polluted stretch study in the Kallayi river stretch. On examining the data published by CPCB during past years, it was noticed that the above same stretch Thekkeppuram to Arakkinar five kilometers is identified as the polluted stretch and marked under priority 5.But on physical examination by the sampling / inspection team, from Kerala State Pollution Control Board District and Regional offices Kozhikode, it was observed that this CPCB allocated stretch is only a small distributary of the main Kallayi River stretch, which joins the Kallayi river at Thekkeppuram just before it joins the sea.

2.1. A1. SELECTION OF SAMPLING POINTS

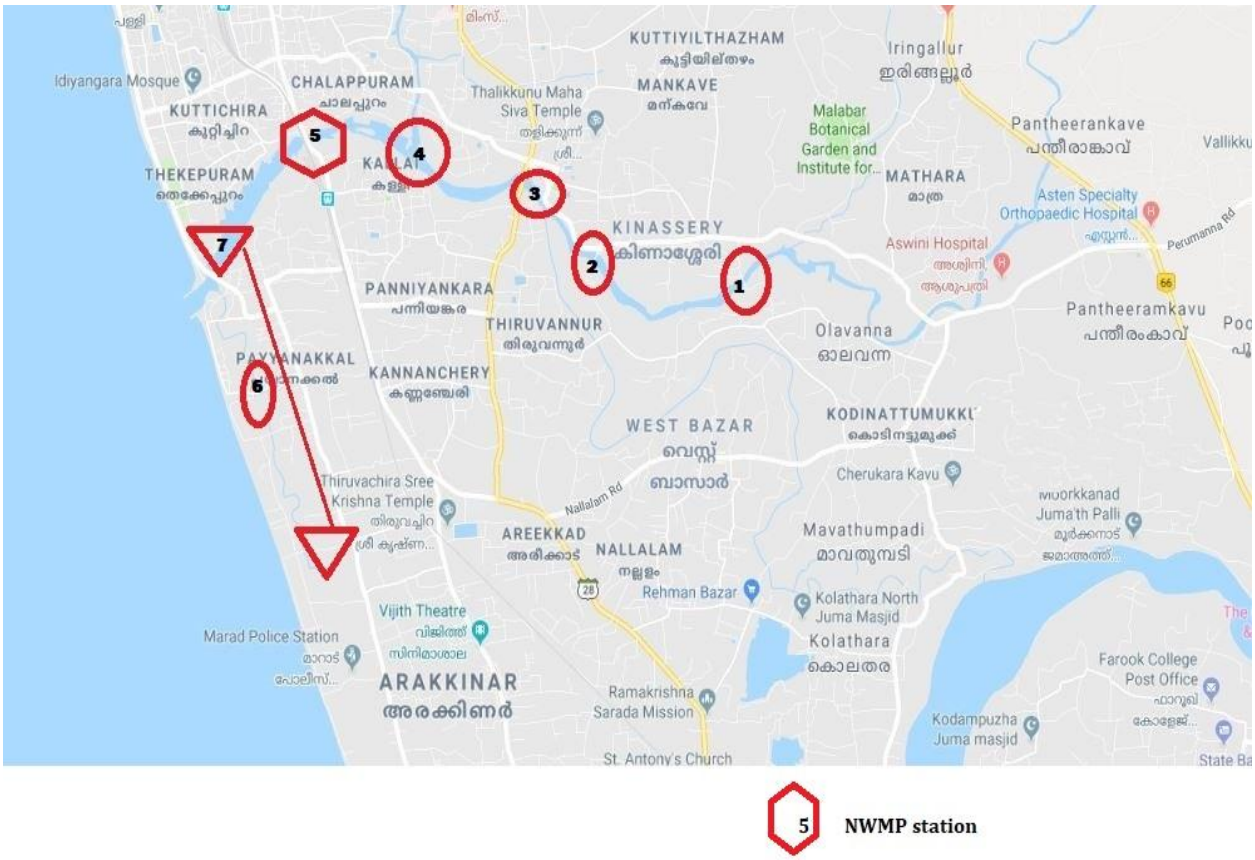

Fig.6. **Google map location of sampling points Kallayi river stretch**

Since or NWMP sampling station [sampling point 5] is at KallayiBridge, which is along the Kallayi main river stretch, we have selected sampling points from Pokkunnu to Thekkeppuram along the main river stretch and a sampling point is also taken at \Payyanakkal which is along the CPCB allocated stretch from Arakkinar to Thekkeppuram. Pictures of the seven sampling points and a brief description on its significance are given below.

2.1. A2. SAMPLING POINTS

1. **Palathumkandibridge, Pokkunnu: -** This Bridge connects Kozhikode Corporation and Olavanna Panchayath. This area is mainly residential. No Industries in the river banks in this area. Private & public drainages discharging in to the river. Individual domestic outlets are connected to this public drain. No industrial outflow. No wood seasoning in this area.

Fig.7. Palathumkandibridge, Pokkunnu

2. Kaduppini Bridge: -Public drainages discharge in to the river. Fish market found in the river bank. Dumping of solid wastes like plastic etc. on the river bank. Wood seasoning also found. No industrial outflow.

Fig.8.Kaduppini Bridge

3.Mankavu Bridge: - Wood industries on the river banks - wood seasoning. Public drainages discharging in to the river. Dumping of wastes like plastic, slaughtering etc. in the river and on the river bank. No industrial outflow.

Fig.9. Mankavu Bridge

4.Mooriyadu: - Joining of Canoli canal in to the river (at Mooriyadu). Wood industries on the river banks - wood seasoning. No industrial outflow.

Fig.10.Mooriyadu

5.Kallayi Bridge: - Cluster of wood industries on the river banks (almost 22 industries are located along the river side) - wood seasoning. Dumping of slaughter wastes. Dumping of solid wastes like plastic etc. on the river bank

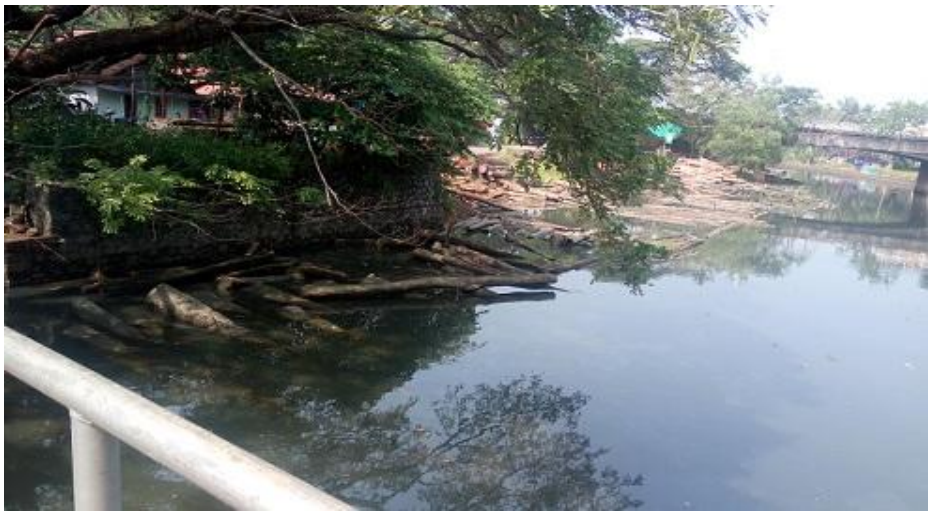

Fig.11. Kallayi Bridge

6.Payyanakkal: - There is lot of growth of water hyacinths; it may be due to the discharge of public drainages in to the river. Dumping of solid wastes like plastic etc. on the river bank.

Fig.12. Payyanakkal

7.Thekkeppuram: - It is the portion where river joins the sea. Public drainages discharging in to the river. Dumping of fish wastes, plastics etc in the river and on the river bank.

Fig.13.Thekkeppuram

Table.4. Water Analysis data of the NWMP station at Kallayi River for the year -2016

MONTHS	PH	BOD mg/L	COD mg/L	NITRATE mg/L	TOTAL COLIFORM MPN/100ml	TDS mg/L
Jan	7	1	16	0.22	1950	23600
Feb	7	1.5	32	0.04	2200	23300
Mar	7.3	1	16	BDL	2000	31600
Apr	7	0.8	8	0.31	2600	25500
May	7.6	BDL	16	0.64	2600	29500
Jun	7.1	BDL	16	0.01	1200	5150
Jul	7.2	1.7	32	0.39	800	9325
Aug	7.6	0.7	8	0.018	60	23450
Sep	7.5	1.8	32	0.52	700	5920
Oct	8	1.9	32	0.19	210	23800
Nov	7.3	BDL	BDL	0.39	900	28600
Dec	7.2	1.1	32	0.412	6200	31980

Table.5. Water Analysis data of the NWMP station atKallayi River for the year -2017

MONTHS	PH	BOD mg/L	COD mg/L	NITRATE mg/L	TOTAL COLIFORM MPN/100ml	TDS mg/L
Jan	7	2.4	32	0.375	6300	28700
Feb	8	1.2	32	0.5	4300	27500
Mar	6.8	1.2	16	1.1	2200	24800
Apr	7.5	1.4	32	1.3	2000	24225
May	7.8	0.9	32	0.76	400	21260
Jun	8.6	0.73	32	0.07	800	24830
Jul	7.5	1	16	BDL	900	421
Aug	7.8	0.93	16	0.5759	70	6370
Sep	8	0.8	16	0.2	170	11700
Oct	7.9	1	16	0.44	210	1590
Nov	7.17	4.5	12	0.2	14000	12500
Dec	7.68	0.6	16	0.36	5200	31000

Table.6. Water Analysis data of the NWMP station at Kallayi River for the year -2018

MONTHS	PH	BOD mg/L	COD mg/L	NITRATE mg/L	TOTAL COLIFORM MPN/100ml	TDS mg/L
Jan	7.21	3.5	32	0.5	5500	28900
Feb	7.35	2.4	24	0.47	5000	32921
Mar	7.95	1	14.4	0.2	6300	33650
Apr	7.3	3.3	16	0.26	15000	29690
May	7.3	3.4	24	0.11	10000	29500
Jun	6.9	3	12	0.28	8600	2900
Jul	6.45	BDL	7	0.364	9600	395
Aug	7.16	0.73	8	0.415	17000	186
Sep	7.48	1.9	12	1.25	6500	2000
Oct	8.89	4.06	16	0.285	6500	11700
Nov	7.21	3.5	32	0.5	5500	28900
Dec	7.62	1.6	32	4.9	9000	22900

Table.7. Water Analysis data of the NWMP station at Kallayi River for the year -2019, up to month April

	PH	BOD (mg/l)	COD(mg/l)	Nitrate (mg/l)	TOTAL COLIFORM((MPN/100ml)	TDS(mg/ l)
Jan,2019	**7.4**	**0.6**	**18**	**4**	**10000**	**28100**
Feb,2019	**7.52**	**2.13**	**18**	**0.586**	**28000**	**18500**
Mar,2019	**7.43**	**1.34**	**16**	**0.8**	**8500**	**24500**
Apr,2019	**7.98**	**1.54**	**18**	**0.9**	**400**	**30000**

The variation of various parameters like pH BOD, COD nitrate concentration, concentration of total coliforms, and total dissolved solids present in the samples collected during the years 2016,2017& 2018 for the NMP sampling station at Kallayi river is plotted in the following graphs.

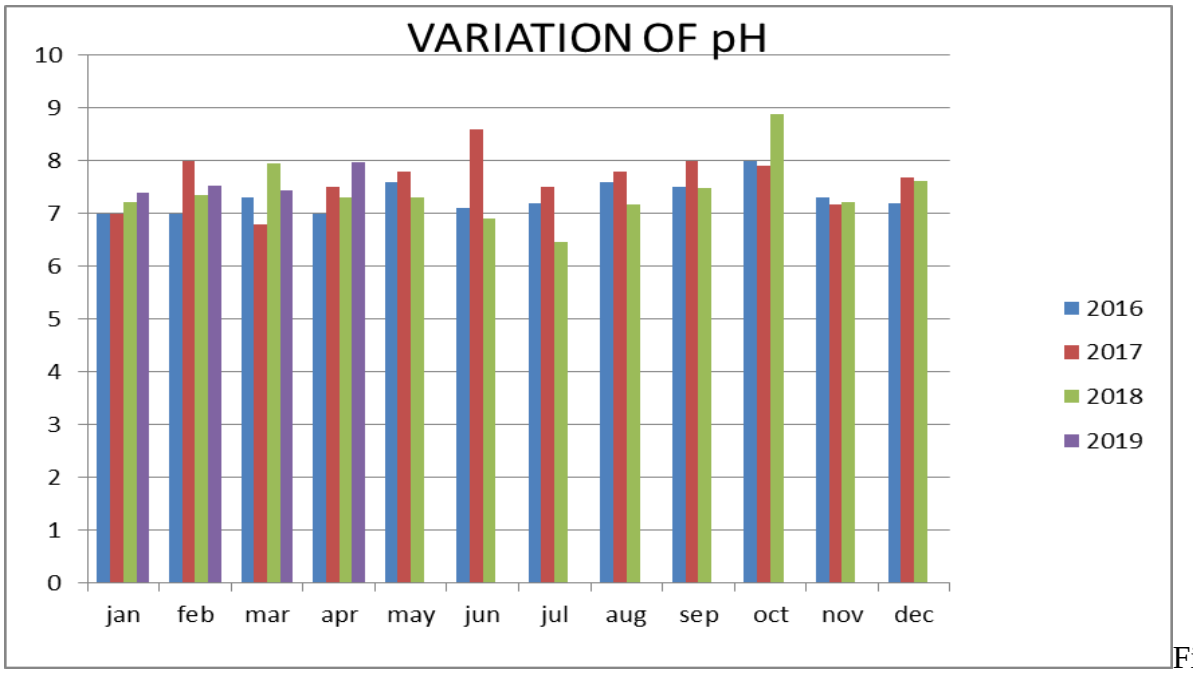

Fig.1

4. Graph showing variation of PH

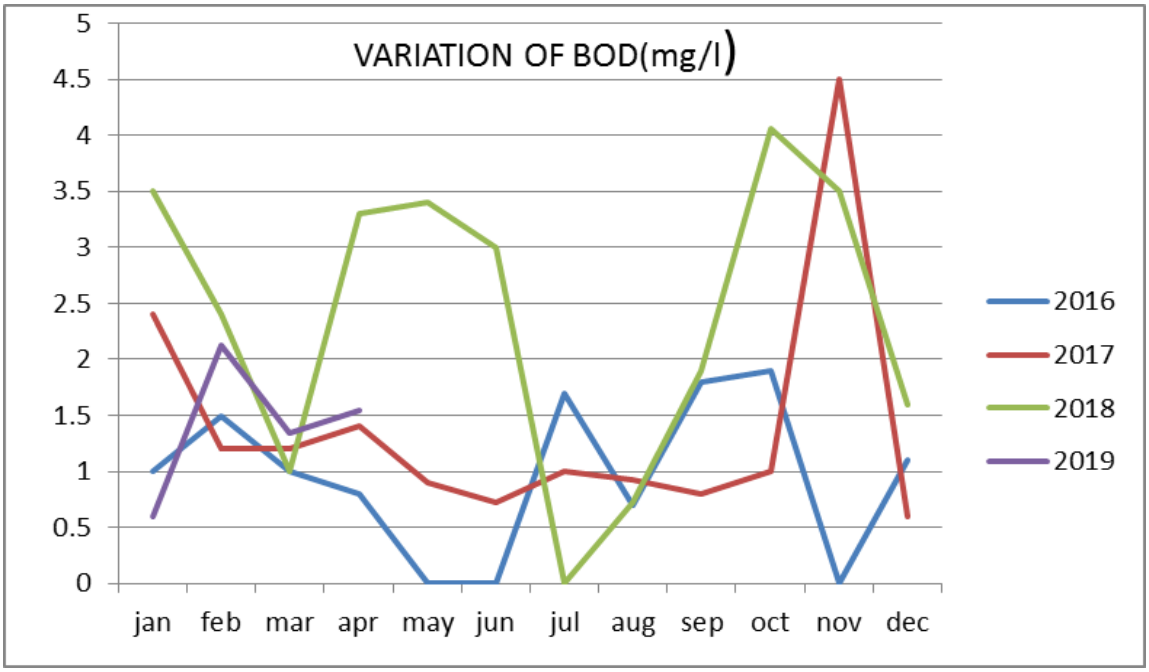

Fig.15. Graph showing variation of BOD

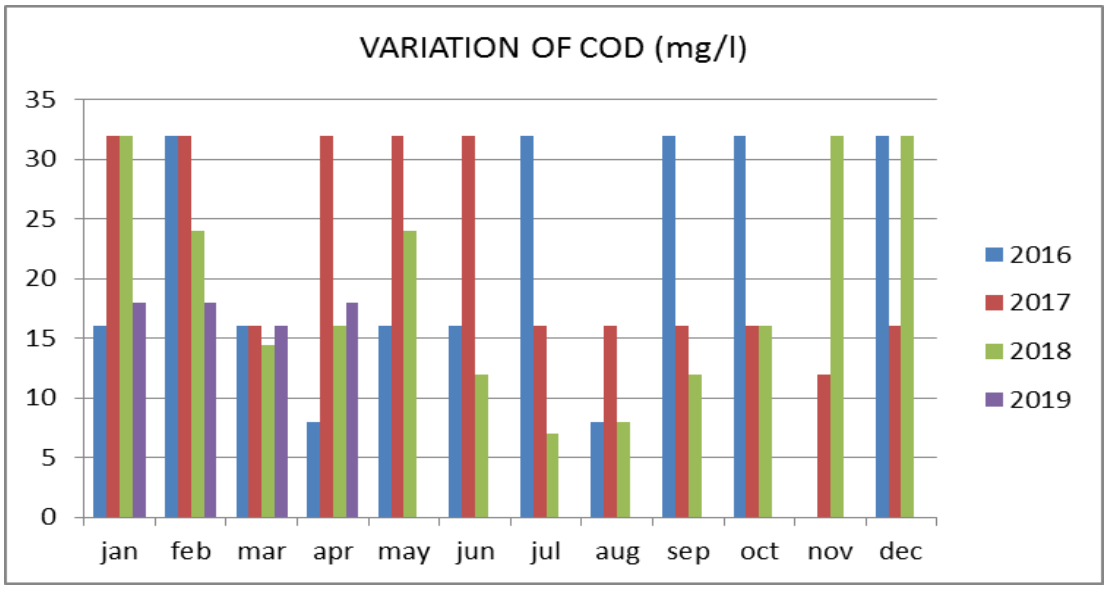

Fig.16. Graph showing variation of COD

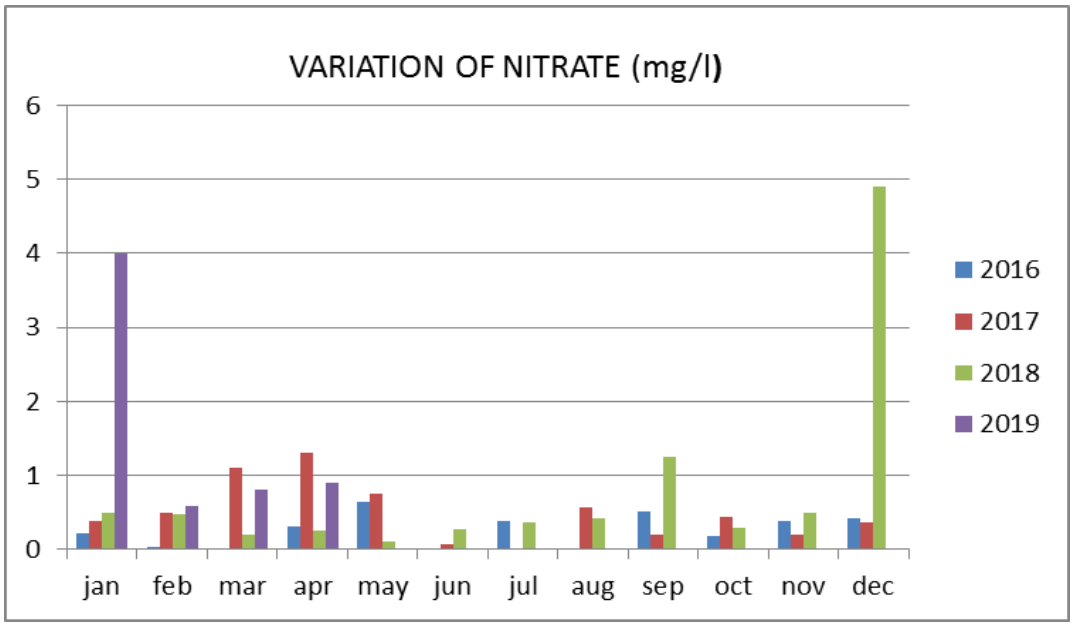

Fig.17 . Graph showing variation of Nitrate

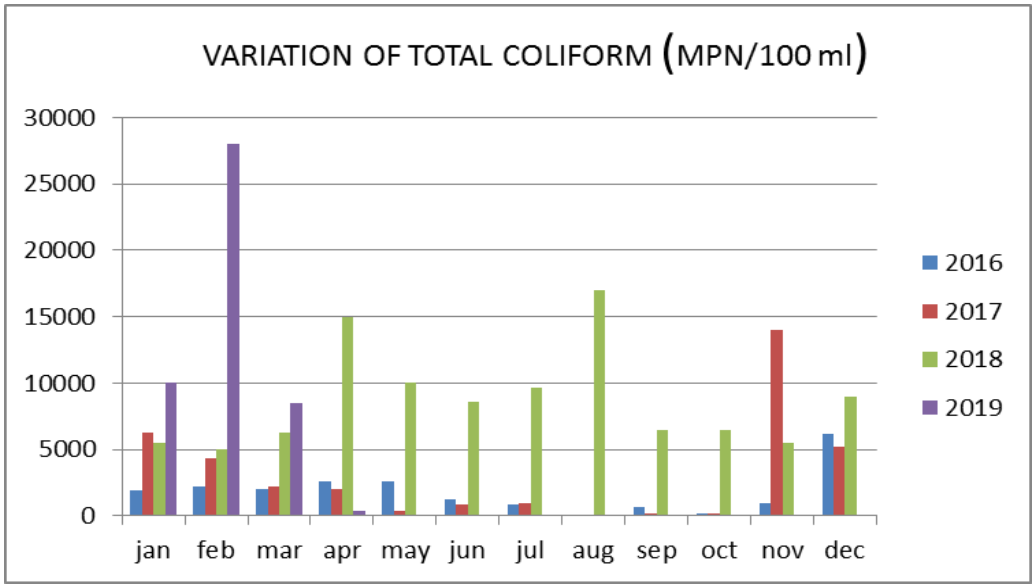

Fig.18. Graph showing variation of Total coliform

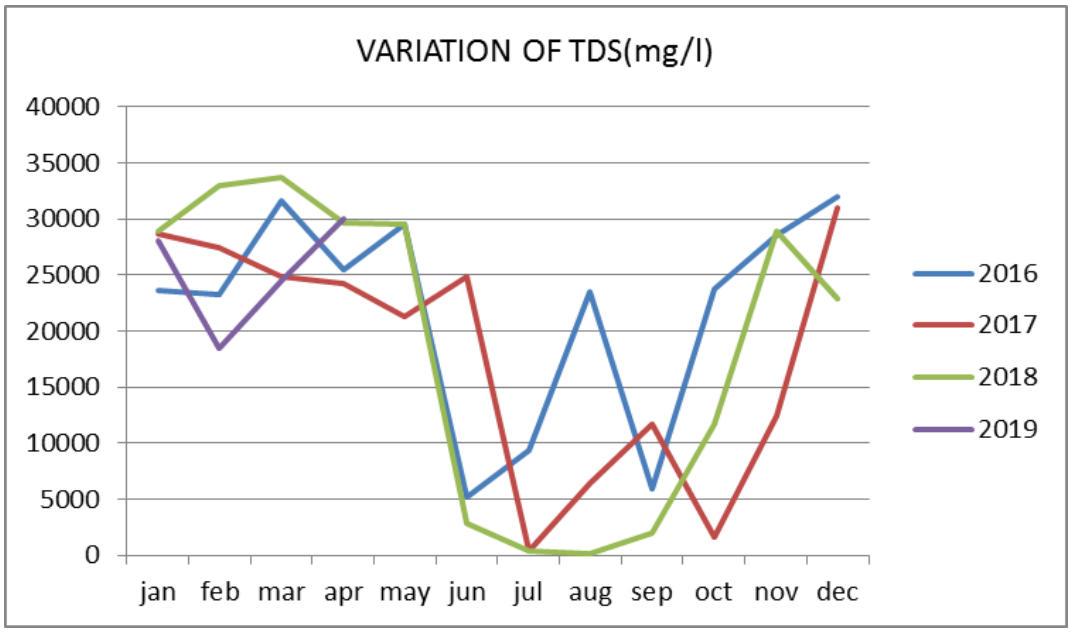

Fig.19. Graph showing variation of TDS

2.1.A3. Water Analysis data: Kallayi - Polluted River Stretch.

Values of parameters Obtained for Samples taken from the New Sampling Points are as tabulated below.

Table.8.Water Analysis data of new Sampling Points of Kallayi

SAMPLING POINTS	PH	BOD mg/L	COD mg/L	NITRATE mg/L	TOTAL COLIFORM MPN/100ml	TDS mg/L
K1	7.13	2	20	0.2378	9200	8950
K2	7.13	1.6	24	0.3274	7900	20850
K3	7.18	1.7	32	0.3397	10400	22200
K4	7.13	2.14	36	0.3126	16000	15400
K5	7.39	1.6	32	0.3595	12200	21300
K6	7.45	8	32	0.2188	9800	7440
K7	7.53	2.14	40	0.3407	11000	24620

From the periodical monitoring data over the years 2016 to 2018 for the NWMP station at Kallayi River, it can be observed that, the BOD values are within limits for most of the period, except for some occasional shoot up which rose to a maximum of 4.5 mg/L during November

2017. Increasing BOD is not a general trend as it is observed. The most noticeable pollution and deterioration of the water quality arises due to presence of coli forms which indicate severe sewage pollution. Amount of suspended solids are also much above permissible limits.

From the newly collected water samples, from the seven stations along the Kallayi river stretch, more or less constant values for pH is observed. Highest value of BOD obtained is observed for the sample taken from sampling point K6, i.e. Payyanakkal, which is 8 mg/l .This increased value in BOD, may be due to the presence of private drainage discharges, solid waste dumping at the site, and due to presence of water hyacinths found largely in the area. All indicates a high value of dissolved nutrients in the region. For other six sampling points, the values of BOD are not exceeding permissible limits as it is observed. Total solids content and total coli form content are extremely high. This may be due to sewage discharge and other solid waste discharges in to the water body through private as well as public drains as observed during the sampling operation.

CHAPTER 3

STUDY OF POLLUTION LOAD

3.1. GENERAL

On examining the data published by CPCB during past years, it was noticed that the stretch Thekkeppuram to Arakkinar five kilometers in the Kallayi River is identified as the polluted stretch and marked under priority V. But on physical examination by the sampling / inspection team, from the District Office and Regional Office of Kerala State Pollution Control Board Kozhikode, it was observed that this CPCB allocated stretch is a portion of main Kallayi River stretch, which joins the Kallayi river at Thekkeppuram just before it joins the sea.

3.1.1 SELECTION OF SAMPLING POINTS OF POLLUTED DRAINS JOINS THE KALLAYI RIVER

North

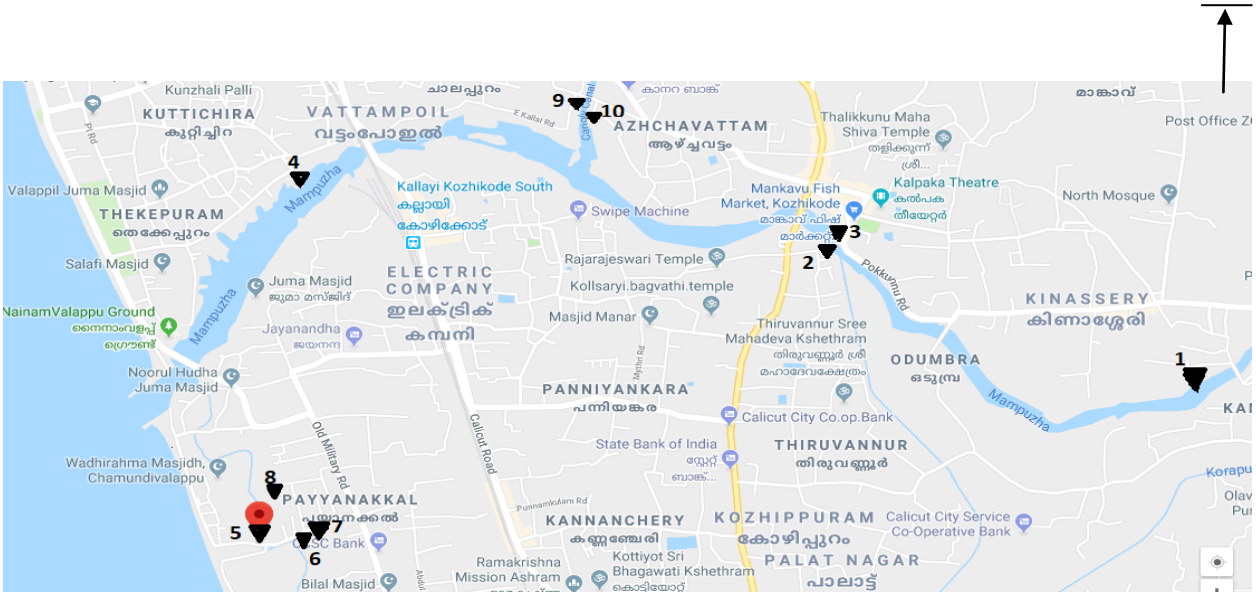

Fig.20. Google map showing location of 10 sampling points

We have selected eleven sampling points. Sampling points from Pokkunnu to Thekkeppuram along the drains which joins Kallayi river stretch and sampling point of the drain at Payyanakkal which is along the CPCB allocated stretch from Arakkinar to Thekkeppuram is

selected.Study of the drain is carried out with the help of EnviSanMobile application. Location of the drain is identified and plotted. Sample is collected from the eleven points.

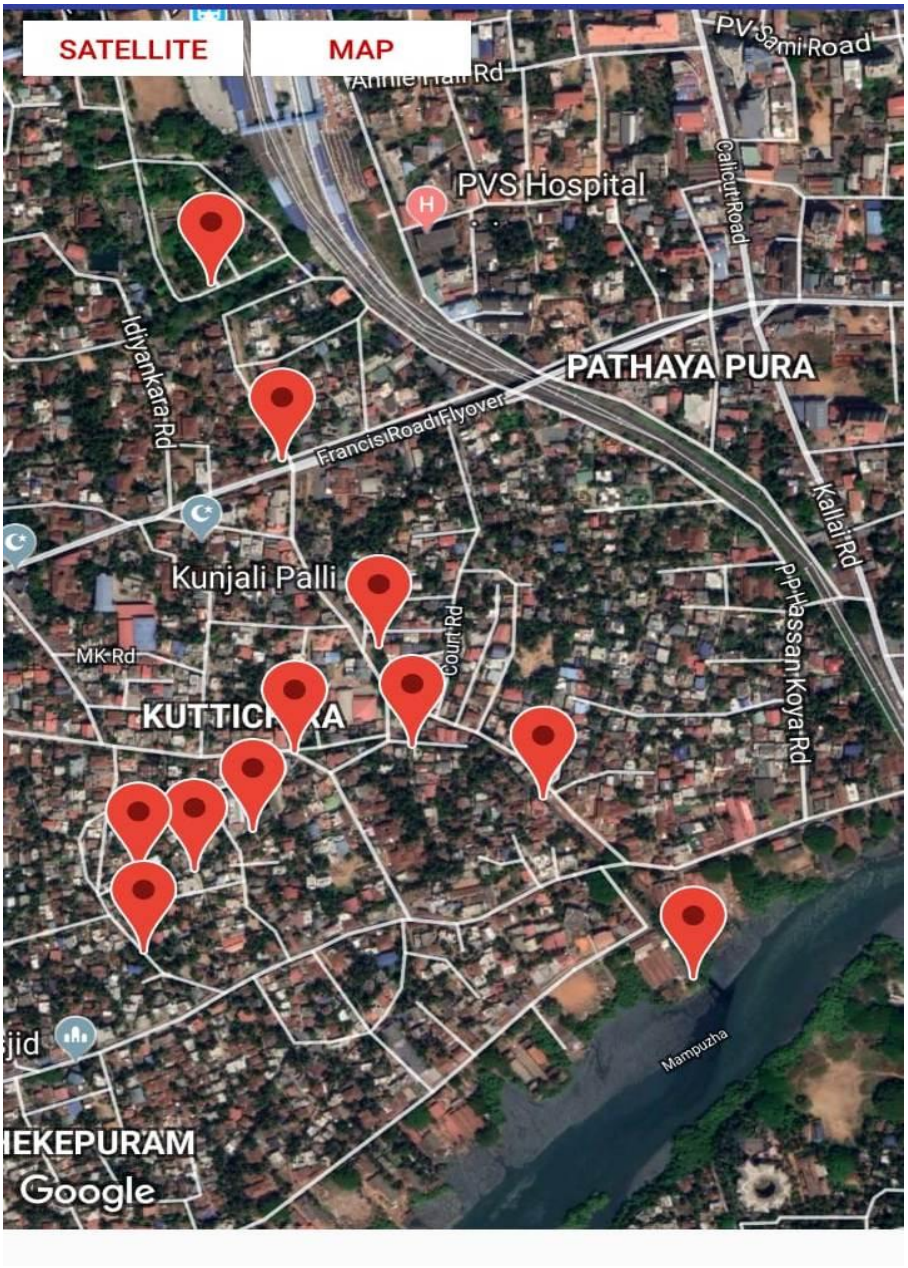

Fig.21. Location of sampling points

Pictures of the eleven sampling points and a brief description on its significance are given below.

1. PALATHUM KANDI BRIDGE

It is a residential area. The drain is 0.5m wide and is closed. It collects untreated waste water from the houses. There are no industries in this area.

Fig.22.Palathum kandi bridge

2. & 3.MANKAVU BRIDGE-1 & 2

The drain are of 0.5m& 0.7m wide and collects water from hotels, institutions etc. Seasoning of woods is also done in the main stream river. Mankavu fish market is nearby. No industries are found.

Fig.23. Mankavu bridge 1

Fig.24.Mankavu bridge 2

4. IBRAHIMPALAM BRIDGE

It is 4.5m wide drain. It collects waste water from Kozhikode city area, railway station premises, etc including hotels, institutions etc. No industries are found.(only furniture units are seen).

Fig.25.Ibrahimpalambridge

5. CHAMUNDI VALAPU BRIDGE

It is an open drain of 11m wide. It collects water from the nearby thickly populated area. No industries are there. Plastic wastes and solid wastes are thrown into the water body. The sullage from houses are opened directly into the drain. The flow is affected by tides.

Fig.26. Chamundi valapubridge

6. PADANNA VALAPU

It is an open drain of 3.6m wide. It collects water from the nearby thickly populated area. No industries are there. Plastic wastes and solid wastes are thrown into the water body. The sullage from houses is opened directly into the drain. The flow is affected by tides.

Fig.27.Padanna valapu

7.PADARTHU VALAPU

It is an open drain of 4.0m wide. It starts from Beypore area and collects water from the nearby thickly populated area. No industries are there. Plastic wastes and solid wastes are

thrown into the water body. The sullage from houses is opened directly into the drain. The water is stagnant and full of mosquito larvae. The flow is affected by tides.

Fig.28.Padarthu valapu

8. UDAYA RESIDENTS ASSOCIATION

It is an open drain of 6.5m wide. It was actually made for coir processing. Presently it collects water from the nearby thickly populated area. No industries are there. Plastic wastes and solid wastes are thrown into the water body. The sullage from houses is opened directly into the drain. The flow is affected by tides.

Fig.29.Udaya residents association

9. MOORIYAD 1

It is an open drain of 0.3m wide. It collects water from the nearby hotels etc. No industries are there. Wood seasoning is found in the main stream river.

Fig.30.Mooriyad 1

10. MOORIYAD 2

It is a open drain of 4.7m wide. It collects water from the nearby residential area. No industries are there. Only furniture units are seen. Wood seasoning is found in the main stream river.

Fig.31.Mooriyad 2

11. PUTHIYA PALAM BRIDGE(Canoli canal)

It is the Canoli canal of 17 m wide where newly collects water from the nearby commercial area, hotels, and restaurants etc.

Fig.32.Puthiyapalam bridge

Details of the eleven sampling points of drains selected and water sampling analysis results tabulated given below Table.8.

Table.9.Analysis result of sampling points

Sl. No	NAME OF DRAINS	LATITUDE LONGITUDE	BOD (mg/L)	TOTAL COLIFORM CFU/100 ml	FECAL COLIFORM CFU/100 ml	FLOW RATE (m^3/sec)
1	Palathumkandi Bridge	11^0 13'40.92276" N 75^0 49'10.64892" E	220	1120	540	0.005625
2	Mankavu Bridge-1	11^0 14'0.22596" N 75^0 48'16.99524" E	220	3400	1500	0.001875
3	Mankavu Bridge-2	11^0 14'1.55004" N 75^0 48'19.38996" E	80	1200	750	0.00378
4	Ibrahim palam Bridge	11^0 14'10.36464" N 75^0 47'5.26776" E	260	3400	2400	0.1215
5	ChamundiValapu Bridge	11^0 13'15.2929" N 75^0 46'59.04921" E	80	8800	5700	0.0616
6	Padannavalapu	11^0 13'16.8204" N 75^0 47'4.56072" E	260	7500	4400	0.005616
7	Padarathuvalapu	11^0 13'16.94064" N 75^0 47'7.67184" E	80	6400	4200	0.008
8	Udhaya Residence Association	11^0 13'22.95336" N 75^0 46'59.10888" E	100	7900	5100	0.01625
9	Mooriyad - 1	11^0 14'21.61176" N 75^0 47'43.28376" E	200	8700	6900	0.00054
10	Mooriyad - 2	11^0 14'21.66792" N 75^0 47'44.41956" E	90	8100	6900	0.022701
11	Puthiyapalam bridge(CanoliCanal)	11^0 14'52.7" N 75^0 47'43.2" E	170	6800	5200	1.275

Details of the sampling points of drains selected and pollution load calculations are given below in Table 9.

Table .10..Load calculations of Drain

Sl. No	NAME OF DRAIN	WIDTH (meter)	WATER DEPTH OF DRAIN (meter)		AREA (m^2)	VELOCITY (m/s)	DISCHARGE (m^3/s)	BOD (mg/L)	BOD LOAD (kg/day)
			present depth of water	maximum depth of drain					
1	Palathumkandi Bridge	0.5	0.09	0.55	0.045	0.125	0.005625	220	106.92
2	Mankavu Bridge-1	0.5	0.15	0.5	0.075	0.025	0.001875	220	35.64
3	Mankavu Bridge-2	0.7	0.05	0.9	0.035	0.108	0.00378	80	26.13
4	Ibrahim palam Bridge	4.5	0.3	1.6	1.35	0.09	0.1215	260	2729.38
5	ChamundiValapu Bridge	11	0.2	0.9	2.2	0.028	0.0616	80	425.78
6	Padannavalapu	3.6	0.12	1.1	0.432	0.013	0.005616	260	126.16
7	Padarathuvalapu	4	0.2	0.7	0.8	0.01	0.008	80	55.30
8	Udhaya Residence Association	6.5	0.25	0.7	1.625	0.01	0.01625	100	140.40
9	Mooriyad - 1	0.3	0.1	1	0.03	0.018	0.00054	200	9.3312
10	Mooriyad - 2	4.7	0.23	1.6	1.081	0.021	0.022701	90	176.52
11	Puthiyapalambridge (Canoli Canal	17	1.5	2.5	25.5	0.05	1.275	170	18727.20

Sample calculation of Palathumkandi Bridge

Width of drain=0.5m, Depth =0.09m, Area=0.045m2, Velocity of drain = 0.125m/sec

Discharge in (m3/s) = Area(0.045 m2) X Velocity of drain (0.125m/sec) = 0.005625m3/s

Discharge in (L/day) = 0.005625 X 86400000=486000 L/day

BOD load in Kg/day = 220 x 486000/ 1000000 =106.92 Kg/day

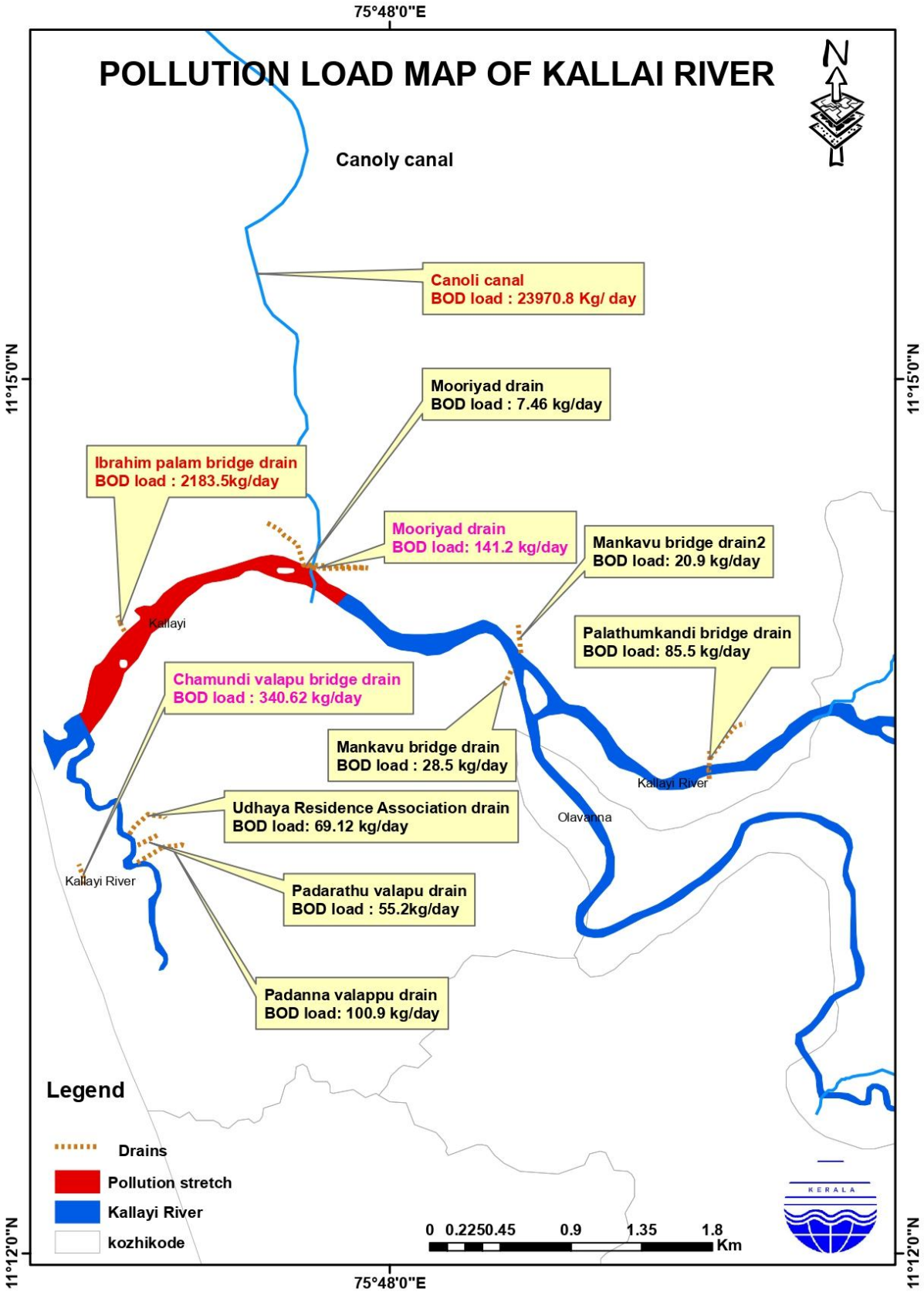
POLLUTION LOAD MAP OF KALLAI RIVER
N
75°48'0"E
11°15'0"N
11°12'0"N
Canoly canal
Canoli canal
BOD load : 23970.8 Kg/ day
Mooriyad drain
BOD load : 7.46 kg/day
Ibrahim palam bridge drain
BOD load : 2183.5kg/day
Mooriyad drain
BOD load: 141.2 kg/day
Mankavu bridge drain2
BOD load: 20.9 kg/day
Palathumkandi bridge drain
BOD load: 85.5 kg/day
Kallayi
Chamundi valapu bridge drain
BOD load : 340.62 kg/day
Mankavu bridge drain
BOD load : 28.5 kg/day
Kallayi River
Udhaya Residence Association drain
BOD load: 69.12 kg/day
Olavanna
Kallayi River
Padarathu valapu drain
BOD load : 55.2kg/day
Padanna valappu drain
BOD load: 100.9 kg/day
Legend
Drains
Pollution stretch
Kallayi River
kozhikode
0 0.2250.45 0.9 1.35 1.8
Km
KERALA

Fig.33.Drains in polluted stretch(Thekkepuram – Arakinar)

Table 11 .Pollution load in drains at Kozhikkode corporation in order of importance

Sl. No	NAME OF DRAIN	LATITUDE LONGITUDE	FLOW RATE (m^3/sec)	POLLUTION LOAD IN TERMS OF BOD (KG/DAY)
1	Palathumkandi Bridge	11^0 13’40.92276” N 75^0 49’10.64892” E	0.005625	106.92
2	Mankavu Bridge-1	11^0 14’0.22596” N 75^0 48’16.99524” E	0.001875	35.64
3	Mankavu Bridge-2	11^0 14’1.55004” N 75^0 48’19.38996” E	0.00378	26.13
4	Ibrahim palam Bridge	11^0 14’10.36464” N 75^0 47’5.26776” E	0.1215	2729.38
5	ChamundiValapu Bridge	11^0 13’15.2929” N 75^0 46’59.04921” E	0.0616	425.78
6	Padannavalapu	11^0 13’16.8204” N 75^0 47’4.56072” E	0.005616	126.16
7	Padarathuvalapu	11^0 13’16.94064” N 75^0 47’7.67184” E	0.0080	55.30
8	Udhaya Residence Association	11^0 13’22.95336” N 75^0 46’59.10888” E	0.01625	140.40
9	Mooriyad - 1	11^0 14’21.61176” N 75^0 47’43.28376” E	0.00054	9.33
10	Mooriyad - 2	11^0 14’21.66792” N 75^0 47’44.41956” E	0.022701	176.52
11	Puthiyapalam bridge (Canoli Canal	11^0 14’52.7” N 75^0 47’43.2” E	1.275	18727.20

It was noticed that maximum pollution load is observed at the drain at Puthiyapalam bridge (Canoli Canal) which is mainly commercial area. Flow at the point is very less and water is highly polluted and stagnated which causes the accumulation of maximum BOD load. Ibrahim palam Bridge is the 2nd largest polluted area observed and flow. Itis the downstream point where waste from the railway station, town, commercial activities and that from the residential area may reach at that point. Pollution load is high at this point. Chamundi Valapu Bridge and Padannavalapu also comes in the same stretch Thekkeppuram to Arakkinar which are purely residential areas. This stretch is only a small distributary of the main Kallayi River stretch, which joins the Kallayiriver at Thekkeppuram just before it joins the sea. This area is also affected by tidal variations. The major source of pollution load at location of drains at Udhaya Residence Association, PadarathuValapu, ChamundiValapu Bridge is domestic effluents, plastic wastes and solid wastes.

Mankavu Bridge-1, Mankavu Bridge-2, Mooriyad – 1 and Mooriyad – 2 are the stations having wood seasoning. These space may be given separate effluent treatment system at the downstream area after wood seasoning.

Ibrahim palam Bridge is the downstream point where waste from the railway station, town , commercial activities and that from the residential area may reach at that point . Pollution load is high at this point.

CHAPTER 4
ACTION PLAN

As per the order G.O(MS)No.12/2019/WRD dated of the Water Resource Department30.04.2019, District level Technical Committee has been formed and the first meeting was conducted on 15.05.2019 at Kerala State Pollution Control Board Regional office Kozhikode, chaired by Chief Environmental Engineer, KSPCB, RO, Kozhikode. The committee members comprises of Superintending Engineer, Irrigation Department North Circle, The Deputy Collector(Senior officer from the Revenue Department nominated by District Collector),Environmental engineer, Kerala State Pollution Control Board, District Office, Kozhikode, Secretary Kozhikode Corporation, Superintending Engineer, Kerala water Authority, District Co-coordinator, District Suchitwa mission, General Manager, District Industries department. During the meeting, it was decided to conduct a joint inspection at the polluted stretch on 17.05.2019. Minutes of the First DLTC meeting is attached herewith as **(Annexure 1A).**

The team comprising the following officers conducted joint inspection on 17.05.2019 :-

1. Environmental Engineer, Assistant Environmental Engineer, Assistant Engineer, Kerala State Pollution Control Board, District Office, Kozhikode.

2. Assistant Executive Engineer, Assistant Engineers from Kerala water authority

3. Manager, District Industries Centre

4. Assistant Executive Engineer, Assistant Engineers from Irrigation department

5. Assistant Coordinator, Suchitwa Mission

6. Assistant Executive Engineer, Assistant Engineers from Kozhikode Corporation

7. Senior Clerk, District Collectorate

The team identified polluted stretches which includes Puthiyapalam bridge (Canoli Canal), Mooriyad– 1,Mooriyad – 2, Ibrahim palam Bridge, ChamundiValapu Bridge, Padannavalapu, Padarathuvalapu, Kothi Bridge .The defects identified in each stretch of drain is same as

mentioned in chapter 3. Environmental Engineer, District Office, KSPCB & the Convener of the DLTC directed other departments to submit draft action plan at the time of second meeting of DLTC, which was fixed on 20.05.2019. Minutes of the joint inspection is attached as **(Annexure 1.B).**

Second meeting of DLTC was held on 20.05.2019 at the chamber of Superintending Engineer, Irrigation Department, Kozhikode. Corporation, Irrigation department, Suchitwa Mission have submitted their draft action plan. Minutes of the second meeting is enclosed as **(Annexure 1.C).** Draft action plan submitted by Kozhikode Corporation, Irrigation department and suchitwa mission is enclosed as **(Annexure 2.A), (Annexure 2.B)** and **(Annexure 2.C).**respectively.

Kozhikode Corporation has inspected and identified several units which are discharge waste water into public places. They have issued notices to 92 units. Among them 30 units installed own facility for waste water disposal in their units.

KSPCB has inspected 14 units including hospitals, commercial establishments, residential apartment complexes, markets, industries, restaurants and found some of the units directly discharging their waste water into drain. Notices has been issued to the 14 units. Copy of the notices issued are enclosed as **(Annexure 3.A).** Routine inspection will be regularly conducted and directions will be initiated to find out the sources of illegal discharges to the public drain.

Direction has been issued to Kozhikode corporation authorities for providing treatment facilities for individual shops, railway station, hotels and other commercial buildings and not to discharge the waste water into the open drain connecting to the river. They have also been directed to take necessary steps to improve waste disposal facility in canal and to provide own facility for the disposal of house hold effluents. Copy of the notice issued is enclosed as **(Annexure 3.B).** Direction has been issued to railway for providing effluent treatment facility for the waste water from comfort stations and providing facility for solid waste treatment. Copy of the notice issued is enclosed as **(Annexure 3.C).**

Irrigation department has included necessary measures in their action to remove the silt and to maintain sufficient gradient in the gradient in the drain, so as to allow the free movement of water in the drain

4.1 Combined action plan

4.1.1 Corporation

Sl. no	Action proposed	Action taken	Implementing agency	Estimated Expenditure	Funding agency	Time limit	Expected outcome
1	Identification of illegal outlets into storm water drain and issue Notice to such units	Issued notice to 92 units. 3o units installed waste water disposal facility in their unit	Corporation	Not needed	-	30.12.2020	Reduced pollution load in drains
2	Waste to energy project proposed at Njeliyamparamba	Approved and Tender accepted	KSIDC	250 Crore	D.B.F.O.T	30.06.2021	Reduced dumping of solid wastes in river and public places
3	Establishment of Aerobic compost units	24 units established in 6 sites 3.1 Tagore Hall(2 no.) 3.2 S.K pottakkad hall 3.3 Jubilee hall 3.4 Mofusil bus stand 3.5 T.B clinic 3.6 Circle office	Corporation	25 lakhs	Own fund	Completed and functioning	Reduced dumping of solid wastes
4	Seggregation of solid wste at source level and treatment of house hold wastes	300 ring compost and 150 biogas plant installed	Corporation	2.5 crore	Own fund	30.06.2019	Reduced dumping of house hold wastes into drains
5	Setting up of rendering treatment plant for chicken stall wastes	Installed in Thamarasseryp anchayath. Now waste is collected from 170 units	Fresh cut agency	12 crore	Private investmen t	on trial run	Reduced dumping of wastes on the banks of river
6	Implementation of Green protocol unit	Purchased 750 steel plates and steel glasses	Corporation	9 lakhs	Own fund	31.06.2019	Reduced use of plastic
7	Setting up of common STP of(13 MLD)		Corporation	Total-116.5 crore	Central/state Govt./mun	31.03.2020	Entire polluted river stretch identified by

		7.1 At Kothi bridge- 6 MLD plant proposed 7.2 At Avikkal -7 MLD plant proposed		56.63 crore 59.87 crore	icipality combined project		CPCB will be free from effluent discharge to public drain
8	Cleaning of Canoli canal	Combined cleaning with public and Government	Corporation	46 lakhs	C.S.R fund(KWIL) and Suchitwa Mission	20.07.2019	Reduced pollution load in canoli canal
9	Purchasing of Solar Boat for Canoli canal cleaning	D.P.C approved the project	Corporation	30 lakhs	Own fund	31.03.2020	Reduced pollution load in canoli canal
10	Installation of CCTV Camera for the Identification and monitoring of illegal activities	D.P.C approved the project. Contacted Keltron	Corporation	30 lakhs	Own fund	31.03.2020	Reduced dumping of wastes in to river, road side.
11	Establishment of Mobile Septage Units	D.P.C approved the project	Corporation	50 lakhs	Own fund	31.03.2020	Reduction of pollution load in river
12	Action taken against dumping of wastes into river and public places	fine RS. 32 lakh imposed	Corporation	-	-	Continuing	Reduction of dumping of wastes in public places
13	Cleaning of B.K canal	Cleaning of canal reaches to kallayi river	Corporation	2.88 crore	Central/state Govt./municipality combined project	31.03.2020	Reduced pollution load in B.K canal leading to kallayi
14	Establishment of treatment plant at Medical college (3 MLD plant)	Tender over 14.1 -2 MLD plant proposed 14.2- 1 MLD plant proposed	Corporation	14.10 crore	Central/state Govt./municipality combined project	31.03.2020	Reduction in pollution load at canoli canal

15	Construction of drains at Y.M.RC Ayyankar colony	Tendering process in progress	Corporation	14.10 crore	Central/state Govt./municipality combined project	31.03.2020	To prevent pollution load in drain leading kallayi
16	Implementation of STP at Kottooli (13.5 MLD)	Hon'ble NGT stayed the project (NGT case no: 215/2016(SZ)	Corporation	90.04 crore	K.S.U.D.P fund (No fund available at present)		Reduction of pollution load in canoli canal. Drains from mavoor road, karaparamb, sarovaram leading to canoli canal will be free from effluent discharge to public drain
17	Treatment facility for waste water in Central market	Tendering process in progress	Corporation	50 lakhs	Own fund	-	Reduction of waste water entering into drains
18	Establishment of comfort stations	Tender accepted	Corporation	90 lakhs	Own fund		Reduction in pollution load to drain
19	Provide facility for MRF,RRF, Super MRF	3 units existing 19.1 Njeliyanparamb 19.2 Industrial estate 19.3 Meyorbhavanjayanthinagar colony	Suchitwa Mission	1.58 crore	Suchitwa Mission fund	Project in progress	Reduced disposal of solid-waste
20	Identification of illegal outlets from house to storm water drain and issue Notice to such Houses	Action in progress as decided in the DLTC	Corporation	-	-	-	Reduced disposal of domestic effluents in to drains
21	Establishment of Plastic shredding unit		Corporation	75 lakhs	Own fund	Project started	Reduce dumping of plastic in public places

22	Establishment of slaughtering unit	Submitted DPR	Corporation	10.5 crore	Submitted to KIFBI		Reduce dumping of slaughter house wastes
23	Cleaning of drains in Kozhikode Town	With the help of Health inspectors and ULCC actions carried on	Corporation	1.68 crore	Own fund andSuchitwa Mission	Ongoing	Reduce pollution loads in drain

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4.1.2 Irrigation Department

Sl. no	Action proposed	Action taken	Implementing agency	Estimated Expenditure	Funding agency	Time limit	Expected outcome
1	Desilting of Kallayi river from Kaduppini to Kothi in Kozhikode Corporation	Proposal submitted under RMF	Irrigation department	7 crore	Revenue Department	31.03.2021	To retain the flow of the river
2	Provide fencing on the sides of the Bridge		Irrigation department	Total 42 lakhs	Revenue non plan	31.03.2021	To reduce the dumping of wastes into river
		3.1 Providing Fencing on Puthiyapalam Bridge across EK canal		6.20 lakhs			
		3.2 Providing Fencing on Mooriyad Road Bridge		7.60 lakhs			

		3.3 Providing Fencing on both sides of Chamundi Bridge		3.60 lakhs			
		3.4 Providing Fencing on both sides of Kothi Bridge		23 lakhs			
		3.5 Providing Fencing on both sides of Ibrahim Bridge		1.60 lakhs			
3	Dredging, Desilting & removal of weeds from E K Canal (11.2 km)	Work entrusted to Kerala Water Ways & Infrastructure Ltd(KWIL)	KWIL	46 lakhs	CSIND	31.07.2019	To ensure free flow in the canal. Removal of silt from the canal mouth near Kallai River is also part of this work.
4	Bio Park in Kozhikode District	Land is to be arranged for the proposed bio park with consultation with local bobies. The details of project may be finalized only after that.	-	-	-	-	-
5	Flood Prone Mapping in Kozhikode District	Food Prone Mapping is proposed for Kozhikode district and the data may be updated after completing the same.	-	-	-	-	-

4.1.3 Kerala State Pollution Control Board

	Activity	Cost	Source of fund	Time line	Remarks
1	River water quality monitoring- Kallayi river	-	National Water Quality Monitoring Programme (NWMP), CPCB fund	Ongoing; monthly frequency	-
2	River water quality monitoring – Kallayi rivers	-	State Water Monitoring Programme, KSPCB fund (SWMP), KSPCB fund	Ongoing. Seasonal monitoring– pre-monsoon, monsoon, post-monsoon	-
3	Inspection and effluent quality monitoring of the flats, industrial units, service stations, hospitals, hotels etc . in Malappuram Municipal area	-	KSPCB funds	Ongoing Interval: Red–1month. Orange – 3 months. Green – 6 months.	-

4.1.4 Suchitwa mission

	Activity	Cost	Source of fund	Time line	Remarks
1	Board displaying messages against dumping to be placed in river banks	RS. 25000/-	Suchitwa mission	15.07.2019	Reduction in pollution loads to drain

4.1.5 Action Plan by Ground Water Department

Sl.No	**Ref para No 48 as per NGT Order no 673/2018 dated20.9.2018**	Activity	Ground Water Department
1	B(i)	Ground Water resources and regulation of ground water extraction by industries particularly in over expolited as critical zones/blocks	As per Groundwater resources of Kerala, 2017 estimate ,Kozhikkode Block comes under the Kallai river basin and the block is safe with stage of groundwater extraction 68.49%
2	B(ii)	Ground water recharging / rain water harvesting	The average pre-monsoon groundwater level is 7.23mbgl. Groundwater Department has implemeted 3 no of dug well recharge schemes at Kozhikkode block
3	B(iii)	Periodic ground waste quality assessment and remedial actions in case of con taminated ground water tube wells/bore wells or hand pumps	Groundwater Department has 1 observation piezometer (BW)in the river stretch.
4	B(iv)	For regulating use of ground water for irrigation purpose, adopting good irrigation practices	The total irrigation draft in the block area is 488.76 ha.m.

4.1.6Action plan by irrigation Department

Sl.No	Ref para item nos as per NGT Order no.673/2018 dated 20.09.2018	Activity	Department	Cost	Timeline
1.	E	Dredging and desilting	Irrigation	KWIL	3 years
2.	E	E-flow (by micro water shed management)	Irrigation	1cr	3 years
3.	E	Flood plane zone (protection and management)	Irrigation	1cr	3 years
4.	E	Grenary development (plant in trees on the banks)	Irrigation	2cr	3 years

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4.1.7 **Specific Remarks**

1. As per item no.7 of the action plan proposed by Kozhikode corporation, a common sewage treatment plant of 6 MLD plant is proposed at Kothi area. If this STP is commissioned, the entire sewage and sullage coming from the Payyanakkal area in the stretch Thekkeppuram to Arakkinar identified by CPCB as polluted drain stretch can be treated and the storm water drain and river Kallayi will be free from the pollution load coming from the residential areas.
2. As per the item no.16 of the action plan proposed by Kozhikode corporation, a Sewage treatment plant of 13.5 MLD capacity was proposed at Kottooli which was proposed by Kerala State Urban Development Project. The STP proposal included advanced and widely accepted treatment technology namely Sequential Batch Reactor. The Integrated Consent to Establish of the KSPCB was issued for the proposed STP. But the application no.215/2016 of the Hon'ble National Green Tribunal was existing and as the proposal was on stay as orderd by the NGT in the above case, the proposed STP has not yet set up. About 12% of sewer lines has been already laid by Kerala Water Authority If the S.T.P gets into operation, the major sources of effluent reaching the Canoli canal from Mavoor road, Karaparamb, Sarovaram which is having the highest pollution load will be treated in the STP and there by the sources of storm water drains reaching the Canoli canal will be free from effluent discharge and which can be a major solution for reduction of pollution load in the polluted river stretch . Therefore the DLTC committee requests the NGT to kindly wave the stay order in application no.215/2016 and kindly permit for the installation of common sewage treatment plant at Kottooli.

Chairperson, D.L.T.C
&
Superintending Engineer
Irrigation Department, Kozhikode

Convener, D.L.T.C
&
Environmental Engineer
Kerala State Pollution Control Board
District Office, Kozhikode

Member, D.L.T.C
&
Superintending Engineer
Kerala Water Authority, Kozhikode

Member, D.L.T.C
&
District Coordinator
District Suchitwa Mission

Member, D.L.T.C
&
General Manager
Industries Department , Kozhikode

Member, D.L.T.C
&
Senior Officer nominated by
District Collector, Revenue Department

Member, D.L.T.C
&
Secretary
Kozhikode Corporation