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Research Article

Advance in Environmental Waste Management & Recycling

The Recycling of Sewage Generated in Kormangla-Chellaghatta Valley of Bengaluru India

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Abstract

The water consumption in Bengaluru goes to 1853 Million Liter per Day (MLD) mainly sourced from Kaveri river and borewells and in result to produce abbot 1400 MLD of sewage. About 711 MLD is being treated water out come from 26 Secondary Treatment Plants (STP) against their capacity of 1360 MLD. About 462.9 MLD is recycled for various purposes and remaining 248.5MLD is allowed to flow in Sewage Water Drainage or in lakes allowed to mix with the sewage, making practically no use. The Bangalore Water Supply and Sewerage Board (BWSSB) has about 6 STPs in place for a capacity of 453.5 MLD in the Kormangla-Chelghatta valley (K&C Valley) catchment area. One of the best-known sewage recycling in present day in the country is 440 MLD Kormangla-Chelghatta valley project for drought prone Kolar and Chickballapur districts in Karnataka, India to reuse of treated water for ground water recharge and industries and then to agriculture. About 76 tanks have been filled till this date.

From these tanks, treated water is allowed to recharge the ground water and then reused through open wells/ borewells for agriculture/ horticulture. No treated water is directly used from such tanks. The project has facilitated to change the socioeconomic status of the farmers, terrestrial, aquatic and marshy ecosystems of the area. The project is bringing change in symbiotic relations by exerting pressure for more sewage treatment at Bengaluru and in turn vegetables/agriculture products supply to it. It also fulfils the obligation of City to provide nutrient rich treated waste-water for farmers' irrigation needs under distress conditions that they are facing due to drought and water shortage, who grow food and vegetables and thus ensuring symbiotic livelihood security for the farmers and food security for the city. The author is working as expert member appointed by National Green Tribunal for the rejuvenation of lakes in K&C Valley.

Keywords: Bangalore Water Supply and Sewerage Board, Central Pollution, Control Board, Kormangla Chelghatta valley, Karnataka State Pollution Control Board, Million Liter per Day Recycle, Sewage, Secondary Treatment Plants, Socioeconomic status.

Introduction

Bendekaaluooru (town of boiled beans), the town/village had its history since Ganga dynasty and subsequent ruled by Cholas and Hoysala dynasties till Nadaprabhu Hiriya Kempe Gowda, a feudal chieftain/rex under the Vijayanagar Empire built a mud fort in 1537 considered to be the foundation of his Gandu Bhoomi or Land of Heroes, the Bengaluru.

Bengaluru is the capital of the Indian state of Karnataka. it has a population of more than10.0 million and a metropolitan population of about 8.52 million, making it the third most populous city and fifth most populous urban agglomeration on the deccan plateau located in southern India at a height of over 900 meter (3,000 ft) above sea level. Bangalore is known for its pleasant climate throughout the year. Its elevation is the highest among the major cities of India. Bengaluru is known by various names like Silicon city, City of Lakes, City of Gardens and presently City of Traffic. Bengaluru consumes about 1853 Million Liter per Day (MLD) potable water sourced from Kaveri river and borewells and in result to produce about 1400 MLD of sewage.

The draft revised master plan for the year 2031 prepared by the Bengaluru Development Authority estimates that the population of Bengaluru could be as high as 20 million and above by the year 2031. This means that the water demand for the city would be as high as 3000 million litres per day. The city then becomes like a diffused dam, receiving and leaving out large volumes of water on a daily basis. Huge quantity of sewage would be produced and there is no option but to recycle/reuse it. There are projections that city may get catch in severe water crisis too.

The Bengaluru is located at highly undulating terrain of upper profile

of good red soil. Due to this character, the areas under occupied township have large number of manmade tanks primarily constructed for the purpose of agriculture/horticulture irrigation and drinking up to twentieth century. The city forms the part of water shed of two principal river basins, Arkavathi to the west and South Pennar to the East. The local topography is characterised by a series of well-defined valleys which radiate from a ridge of High Ground to the north of the city and fall in a gradual manner towards wide belt of flat land extending beyond the limits of the metropolitan area to the South. This results to three principal valleys known as Vrishabhavathi, Koramangala and Chellaghatta and the three valleys run generally in a north to the south direction and divide the greater part of the metropolitan area which lies to the south of the ridge into three separate and distinct drainage zones.

A fourth valley system referred to as the Hebbal series forms drainage zone to the north of the ridge and runs in north easterly direction. In addition, five minor valleys, the Kathriguppa and Tavarekere to the south, the Arkavathi and Kethamaranahally to the north west and Marathhally to the east falls outside the tributary area of the major valleys and they drain independently to the fringe areas which form the remainder of the metropolitan area. The configuration of valleys in well graded side slopes of their tributary areas has provided Bangalore with a natural system of drainage without recourse to pumping. This natural drainage system facilitates both sewerage and storm water to flow by gravity beyond the city.

The focus is laid in this article is the Koramangala Chellaghatta valley lake series (K&C Valley) located in the east of Bengaluru urban district encompassing nearly 35.7% of Bruhat Bengaluru Mahanagara Palike (BBMP) spatial extent and constitutes largest among the three major lakes series in Bengaluru. K&C Valley catchment extends between 12.8365oN to 13.0153oN and 77.5651oE to 77.7873oE with a spatial extent of 292.38 sq.km. The catchment has nearly 82 lakes, some of which dates back to over 1400 years, such as the Agaram lake, Bellandur lake built during the Western Ganga Dynasty in the early 5th century. The nalhas/tributary streams of K&C Valley catchment further move and merged with the Dakshina Pinakini, a seasonal river. The Hebbal and Yelahanka tributary streams converge with the Varthur lake series at Nagondanahalli village (BBMP Ward 94 – Hagadur). It is to state here that most of the lakes are silted (or being filled with C&D debris). Some of the lakes (not the part of 82 tanks) have been made disused and converted into layouts and presently water bodies do not exist. This is one of the main reasons for flooding of the eastern part of the Bengaluru during rains.

An autonomous body i.e. Bangalore Water Supply and Sewerage Board (BWSSB) has been constituted by the State legislature under Bangalore Water supply and Sewerage Board Act on 10-09-1964 for Water Supply & Sewage disposal. It is one of the first Water supply & Sanitation Utilities in India with jurisdiction of entire Bruhat Bengaluru Mahanagara Palike (BBMP) Area of 800 Sq. km, (Bengaluru Core area of 245 Sq. km, 8 Urban Local Bodies of 330 Sq. km (7 City Municipal Corporation, 1 Town Municipal Corporation and 110 Villages of 225 Sq. kms.) It mandates to adequate water supply to meet demand; creation of sewerage network & safe disposal of sewage; Preparation, implementation of plans & schemes for augmenting water supply & safe disposal of sewage; Levy and collection of water charges on 'no loss no profit basis for sustainability of the system.

It is observed that most of the STPs are not running to their full capacity. The BWSSB to make proper arrangements to feed the required quantity of sewage by strengthening the UGD networking to supply to the existing and to be constructed STPs. A proper mechanism should be developed / placed to identify the blockages in the existing UGDs and to attend them mechanically. The present pathetic status of lakes in Bengaluru is mainly due to the un-sustained inflow of partially treated or untreated sewage and untreated industrial effluents. It is to be noted here that the first priority of use of treated water from all the STPs shall be to feed and maintain the full water level of the lakes and remaining surplus water should only be used for other purposes.

To understand the generation of sewage, its treatment and recycle, it is necessary to understand the present status of water supply in Bengaluru. Till the year 1896, unfiltered water was supplied to Bangalore city in the Kalyani system from a number of tanks such as Dharmambudhi, Sampangi, Ulsoor, Sankey etc., supplemented by local open wells and stepped ponds. The supply was inadequate from these tanks, hence, Arkavathi river was identified as the first large reliable source in the year 1884 and filtered water supply was started in the year 1896. Due to the continuous expansion of the city and the rapid growth of population, it became necessary to find and develop new sources. Cauvery river was identified for water supply and allocation of water from Cauvery river was done by Government of Karnataka (GoK). Since 1974, the Cauvery source has been developed in stages (stages i to iv for 1440 MLD) for water supply. Presently no water is drawn from Hessarghatta reservoir.

About 1400 MLD of sewage is expected to be produced against the 1853 MLD potable water consumed in the city. The Bengaluru Water Supply and Sewage Board have established 26 STPs for a capacity of 1360.5 MLD for secondary treatment of sewage. Out of the said quantity, around 711.4 MLD is the outcome of treated water (varies from time to time). It is further observed that about 462.9 MLD 248.5MLD is being used for various purposes and the remaining 248.5MLD is being discharged in Sewage Water Drainage or in lakes allowed to mix with the sewage making practically no use. About 11 STPs of a capacity of 520 MLD are under construction. BWSSB has taken some action now. The BWSSB has to go a long

way to make the city free of sewage water and then make use to substantial purpose.

The BWSSB has about 6 STPs in place for a capacity of 453.5 MLD in the K&C Valley catchment area. Further, the BWSSB has also taken up construction of another 6 STPs for the capacity of 205 MLD. Hence, 658.5 MLD of sewage would be treated by 2020 in this catchment area. The BWSSB reports that presently about 583 MLD outflow from Varthur lake (this includes the treated water from K&C Valley STPs). By taking this into consideration the total sewage generated and its treatment, there shall not be any untreated sewage left and to flow in the lakes. But the situation is otherwise. The BWSSB shall have to take note of it and workout a proper planning/reorient to treat the entire sewage to make it zero flow into the lakes. The BWSSB shall have to properly design its Under Ground Drainage (UGD) network so as to feed the existing STPs of their full capacity and also to the STPs under construction. In addition, it should also ensure that the treated water shall be reused after meeting the requirement of all the tanks in the catchment area.

Results and Discussion

As per the records, the Bengaluru Water Supply and Sewage Board (BWSSB) has established 26 STPs for a capacity of 1360 MLD secondary treatment of sewage. Out of the said quantity, around 711.4 MLD is the outcome of treated water (quantity changes depending on performance). It is further observed that about 462.9 MLD is being used for various purposes and the remaining 248.5 MLD is being discharged in Sewage Water Drainage or lakes, allowed to mix with the sewage water making practically no use. BWSSB has taken some action now. The BWSSB has to go a long way to make the city free of sewage water and then make use to substantial purpose. UGD network and STPs in the City is briefed in

Table 1: Sewerage Network and Sewage Treatment Plants in all valleys of Bangalore.

Sl. no	Valley	Existing Sewerage Net work in Kms	New sewerage Network in Kms	Existing capacity (MLD) and treatment plants	New capacity (MLD) and treatment plants
1	Koramangala & Challaghatta	1481.000	1939.500	305 (5)	150 (2)
2	Vrishabhavathi	1649.000	1208.440	276 (4)	403 (5)
3	Hebbal	480.166	1021.760	140 (5)	86 (5)
4	Sub Total	3610.166	4169.700	721 (14)	639 (12)
	Total	7779.700		1360 (26)	

Project for supply of 440 MLD of secondary treated water from K&C valley and Bellanduru STPs to rejuvenate 126 tanks of Kolar and Chikkaballapura districts

Water is today perceived by the public as a social right to be make available by the Government rather than a scarce resource which shall be managed locally as a socio-economic good to ensure its effective use. In the democratic system of governance in India, public exercise its pressure for their legitimate/otherwise demands to get fulfilled. Water being scarce resource in Eastern plains of Karnataka, one such region is Kolar and Chickaballapura districts in the State that has faced increasing incidence of dry spells and low water availability for its drinking, agricultural and industrial needs. In general, the water supply / irrigation system has been designed and implemented based on the ground water as well as the storm water collected into the various natural water bodies or irrigation tanks constructed for the purpose. Towards this objective, this program/ project had been planned for this water-starved region to recharge through percolation to ground water of the area and then recycle to use through open and borewells.

The regional districts are traversed/crossed with three seasonal rivers viz., Palar, North Pennar and South Pennar. Ultimately these rivers move to the neighbouring State of Tamil Nadu. Due to erratic monsoon, disturbance in catchment, the river flow has dwindled to minimum which cannot be harnessed for sustainable water supply and irrigation. This was one of the reasons that the area went into changing the agriculture practices to Eucalypts/ Casuarina planting in last three decades.

During the past 20 years, erratic rainfall has affected the water resources in the districts. Due to continuous drought conditions and high consumption, the underground water resources have been exploited for drinking water supply and irrigation purposes. Due to over exploitation, ground water resources have dwindled substantially and the water table has gone to a depth of 350-500

meters but not adequately available. It is also observed that since last 20 years numerous tanks have gone dry due to paucity of rainfall and disturbance in catchment areas.

About 1400 MLD of sewage is being produced against the 1853 MLD potable water consumed in the city. Presently more than 711.0 MLD is treated in real terms against the establishments (STPs) of 1360 MLD. This, large quantity of secondary treated water from major Sewage Treatment Plants (STPs) of BWSSB is/was discharged into the existing drainage nalas / rajakaluves/lakes after treatment. Now, out of this treated water, the recycling to use in Kolar district was taken up in this project and completed. For Chickaballapur and other districts, the treated water is supplied and recycled from Hebbal valley. The details are given

Table 2: supply of secondary treated water from Bangalore to Kolar, Chikkaballapura, Bangalore rural and Bangalore urban districts.

		Allocated Water					Tanks filed till now		
Sl No	**Scheme**	**MLD**	**TMC**	**Proposed No of Tanks**	**Live Capacity as per Contour Survey (Mcft)**	**Live Capacity as per Contour Survey (TMC)**	**Tanks**	**Check dams**	**Water Pumped (TMC)**
1	Koramangala & Chalaghatta valley project for Kolar	440	5.67	126	6570.00	7.7	76	93	4.95
2	Hebbala & Nagavara valley project for Chikkaballapura	210	2.71	65	3900.00	3.9	15	10	1.07
	Total	**810**	**10.44**	**290**	**10470**	**11.6**	**85**	**103**	**6.02**

The Koramangala and Challaghatta valley waste water treatment plants are located close to Bellandur and Varthur Lakes, (they are among the largest lakes in Bengaluru) and the generated treated water was discharged fully into the contaminated untreated waste-water of these lakes. This combined, treated and untreated waste water then flows from these lakes into the Dakshin Pinakini river course. The treated water which was diverted to these lakes making it full waste. Farmers all along the river have been using the sewage water, even pumping it far distances, for irrigation purpose. Now after this project, all the treated water of all STPs at K&C Valley (Belandre)is channelled to Kolar district. Some more STPs are coming up at this valley, the expected generation of treated water and its allotment is given in

Table 3: Generation of treated water at K&C Valley for recycling/reuse by minor irrigation department for agriculture, horticulture, floriculture and others.

Sl. No	**Name of the STP**	**Capacity (in MLD)**	**Quantity committed to Minor Irrigation Department (in MLD)**	**Remarks**
1	K & C Valley	218	218	
2		30	30	
3		60	60	
4	Bellandur Ammanikhane	90	90	
5	Kadabeesanahalli	50	-	Committed to Industrial purpose
6	Sarakki (Recently commissioned)	5	4	
Total of Existing STPs		**453**	**402**	

B	Under Construction STPs			
	Agara	35	30	
	K & C Valley	150	120	Anekal taluk
	Hulimavu	10	9	
	Chikkabegur	5	4	
Total of Under Construction STPs		**200**	**163**	
Total		**653**	**565**	

The operating STPs of 90 MLD at Bellandur Amanikere, 60 MLD STP at K&C Valley, 5 MLD STP at Sarakki and under construction STP's of 150 MLD at K&C Valley, 5 MLD at Chikkabegur, 10 MLD Hulimavu and 35 MLD STP at Agaram are/will functioning with device of Biological Nutrient Removal process. The working STPs at Cubbon Park and Lalbagh are Tertiary Treatment Plants. For the 248 MLD (KC Valley), the functioning with Biological Nutrient Removal process would be completed this year. Further, for the work of upgradation / re-habitation of other existing STPs at KC Valley will also be completed this year.

It is to state here that one of the broad objectives of the Government of India Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) is to explore the feasibility of reusing/recycle of treated municipal waste water for semi - urban agriculture and attract greater private investments in irrigation and also recharge of aquifers and introduce sustainable water conservation practices. This will in turn increase agricultural production and productivity and enhance farmers income. This project is built up on this line.

This project is one of the first in India to formally use secondary treated waste-water at such large volumes to fill empty tanks to recharge the ground water. Thus, aims at improving the groundwater table in drought affected area and rejuvenation of bore wells and open wells would be the only way to bring the parched lands back into agriculture operations and improves the ecosystem, provides water for agricultural use in the high drought prone area. It also fulfils the obligation of a city to the farmers who grow food and vegetables and under distress that they are facing due to drought and water shortage and seeks to provide nutrient rich treated waste-water for their irrigation needs, thus ensuring symbiosis livelihood security for the farmers and food security for the city.

The project seeks to supply 440 MLD of secondary treated waste-water from some sewage treatment plants of Bengaluru city to fill the lakes of drought prone Kolar and Chikkballapur districts and provide irrigation water for farmers through the recharge from these tanks. If done well following the guidelines of the WHO the project has potential to provide irrigation water to 24,000 Hectares of land using drip irrigation systems, reduce fertiliser use by 60 %, drought proof the land so receiving the water, enhance shallow aquifer levels, enhance bio-diversity and provide for piece-culture. By putting in place an independent and robust multi-disciplinary monitoring system, by including constructed wetlands and algae ponds as part of the design and by being inclusive and building trust and partnership with farmers, this project may turn ultimately life transforming in a drought affected district.

With this background, the Government of Karnataka had taken a decision to make use of the secondary treated water from the STPs as source of water for filling the existing empty Minor Irrigation Tanks by pumping treated water to a suitable distribution point and later supply the same by gravity or further pumping to Minor Irrigation Tanks, wherever feasible. In this regard, the State has identified 126 tanks in 06 Taluks of Kolar district and Chintamani taluk in Chikkaballapura district to benefit from this K & C Valley Project. The technical details are given in

Table 4: Further the details of tanks, like numbers, water spread area etc. are given in

Sl.No	Stage	Description	Raising main length(KM)	No of Pumps & Motors	Pump Capacity in HP	Present Status
1	Lift-1	K & C Valley to Bellandur Jack Well	9.7	3+1	1045	Work Completed, Water is pumping to Lift - 2
2	Lift-2	Bellandur to Lakshmisagara	42.6	3+1	3780	Work Completed, Water is pumping to Lift - 3
3	Lift-3A	Narasapura to Ridge Point 1	5.2	2+1	1072	Work Completed, Water is pumping to Ridge Point -1
4	Lift-3B	Narasapura to Ridge Point 2	3.2	1+1	382	Work Completed, Water is pumping to Ridge Point -2
5	Lift-4A	Shivarapattana Kere to Channapura Tank	6.5	1+1	570	Work Completed, Water is pumping to Ridge Point
6	Lift-4B	Shivarapattana Kere to Bhavanahalli Tank	5.7	1+1	214	Work Completed ready pump bavanahalli
7	Lift-5	Holali Tank to Kadripura Yerakalkunta Tank	17	2+1	998	Work Completed readyto Pump Mulbagal
8	Lift-6	Janaghatta Tank to Dandupalya Tank	30	2+1	1729	Work Completed ready to pump srinivasapura

Administrative details of the project

Administrative Approval no: Govt order no. MID 44 LIS 2015 (Tech) Bangalore, Dated: 20-10-2015

Estimated Cost Rs.1280.00 Crores. The cost has been increased. Technical sanction No. CER No 91/2015-16 Dated: 10-03-2016. Date of commencement of works: 25-06-2016.Date of commissioning/launching of project: 02-06-2018. The pumping of the treated water was started and as of now Total 76 tanks filled in Kolar district.

Table 5: Technical details of K & C valley Project

Abstact								
Sl no	Taluk	Assembly/ Constiuency	No of Tanks			Total tanks	Atchkat (Hectares)	Water Spread Area (Hec)
			MI tank	ZP Tank	Others			
1	Kolar	Kolar	11	15	3	29	**4370.71**	**890.13**
2	Srinivaspura	1. Srinivaspura	4	15	-	19	1774.4	1053.62
		2. Kolar	5	-	-	5	2952.64	849.84
3	Chinthamani	Chinthamani	-	5	-	5	158	-
4	Malur	Malur	7	17	-	24	2636.27	605.76
5	Bangarpete	1. Bangarpete	3	5	-	8	2158.94	493.77
		2. Kolar	3	-	1	4	393	185.73
6	KGF	KGF	1	-	1	2	1261	615.54
7	Mulbagal	Mulbagal	11	19	-	30	3226.06	702.4
		Total	45	76	5	126	18931.02	5396.79
No of MI tanks:-		45						
No of ZP tanks:-		76						
KUWSDB tanks:-		4					***Executive Engineer***	
Town municipal tanks:-		1					***Minor Irrigation Division, Kolar***	
Total		**126**						

Socioeconomic impact of the project

As planned, about 126 tanks are likely to be filled under this project. This would mean that the agricultural land here would be completely drought proofed. The agricultural activities would be continued throughout the year resulting to provide livelihoods to farmers, farm workers, fisher folks and would support the two industrial areas of Narasapura and Vemgal with significant investment in industries since there would not be any water shortage. Livelihoods of farmers and farm workers is secured in this era of climate change.

At present 76 tanks and 89 check dams have been filled with the secondary treated water. Agricultural activities are in full swing in about 2000 hectares of land. Groundwater tables have risen in the hydro-geological command area of the tanks. Eucalyptus plantations which were planted in past are being removed voluntarily by farmers and started cultivation of Paddy, millet (Ragi), Jowar & vegetables together with horticulture crops. Distress migration is halted and village economies strengthened. Food security for the city and nutrition security for the villages is slowly picking up.
Ecosystems (terrestrial, marshy and aquatic) have been revived with the return of small reptiles, mammals, fish and birds to these tanks. Deer's, peacocks, wild boars and even leopards have been found place for re-habitation in the adjoining State Reserved forests and also in agricultural fields.

The potential for replicability of such projects is huge. Already projects are ongoing to transfer 210 MLD treated wastewater to Chikkaballapura district and another to transfer 120 MLD to Anekal Taluk in Karnataka. The project can be replicated in both mega cities and large and small towns in semi-arid India with an agricultural hinterland
The agricultural community has been involved in the decision-making process for which crops are grown with water efficiency. The lakes will be maintained by the Gram Panchayaths and Zilla Panchayaths.

The project will provide design guidelines for other projects. Standards of treatment for waste water based on a fit for purpose use can also be developed, Nutrient and water recovery from waste water will be ensured. The Food- water – energy nexus will be addressed.

Awareness campaign

The Groundwater Directorate is conducting ground water awareness programmes every year to School / College students, general

public and for the officers of the line departments. In Kolar district in the past two years two workshops for the officer of line departments, four awareness programmes to School / College students and two awareness programmes for general public has been conducted.

Hoardings are installed at places where a greater number of public meets; such as Taluk Panchayat office and Taluk Offices. A total of 10 Hoardings (two hoarding per taluk) has been installed in Kolar district. Radio and TV programmes depicting the importance of judicious groundwater usage and recharging of ground water were telecasted during 2018-19. Tank User's Associations (TUA) which were formed earlier are being revived and that new ones are formed at place where there were no TUAs present.]

The department is actively participating the Central Government initiated "Jal Shakthi" Abhiyaan program and creating awareness among public, school children about groundwater judicious usage, management, conservation and recharge.

The demand for treated wastewater means that an emphasis is placed both on collection and treatment of all sewage generated in the city. This means that pollution of lakes and streams can be minimised and avoided thus cleaning the water bodies.

Community based participatory approach

The agricultural community has been involved in the decision-making process for which crops are grown with water efficiency. The lakes will be maintained by the Gram Panchayaths and Zilla Panchayaths. An action plan for IEC (Information Education and Communication) for involving various stakeholders comprising the local beneficiary communities, the GP, elected representatives, CBO (Community Based Organizations) will be prepared. In respect of each of each tank, a TUA (Tank User Association) will be formed to ensure proper water management. Karnataka has successfully implemented a similar project earlier jalasamvardhane over a decade ago and will incorporate the learnings from the past experience.

There were issues regarding quality of treated water was agitated before the Supreme Court of India. In that connection, the Minor irrigation department have got analyzed the water quality. Two samples of that analysis are given inTables-6 and 7

1. Name of the Location : Chinar tank
2. GPS Location of Monitoring : 13° 4'16.08* N, 78° 03' 5.75'' E
3. Name of the Project : Continuous checking of water quality of . secondary treated water at STP inlet point of of Bellanduru Lake and tanks of Kolar & Chikkaballpur Districts.
4. Sample Collected by : M/s. Environmental Health and Safety Research & Development Centre, Bengaluru- 560 010.
5. Date of collection : 26.12.2019
6. Particulars of Sample Collected : Surface water, Grab Sampling
7. Date of sample Receipt : 27.12.2019
8. Sample Number: EHSRDC/KC/W/19/12/11108
9. Protocol: APHA, 23rd Edition

Table 6: Water analysis of Chinnapur tank of Kolar district

Sl. No	Parameters	Unit	Test Methods	Results	Standards prescribed for Inland surface Water
1.	pH	-	APHA 4500H* B	8.29	5.5-9.0
2.	Electrical Conductivity	us/cm	APHA 2510 B	618	Not Specified
3.	Turbidity	NTU	APHA2130 B	0.97	Not Specified
4.	Dissolved Oxygen	mg/L	APHA 4500-0 C	4.8	Not Specified
5.	Total Dissolved Solids	mg/L	APHA 2540 C	432	Not Specified
6.	Total Fixed Solids	mg/L	APHA 2540 C	209	Not Specified
7.	Suspended Solids	mg/L	APHA 2540 D	18	100
8.	Chemical Oxygen Demand	mg/L	APHA 5220 B	41.6	250
9.	BOD (3 Days @27°C)	mg/L	APHA 5210 B	10	30
10.	Nitrate Nitrogen as NO3-N	mg/L	APHA 4500-NO3 E	1.37	10
11.	Boron as B	mg/L	APHA 4500-B B	0.18	Not Specified

12.	Potassium as K	mg/L	APHA 3500-K	15.2	Not Specified
13.	Sodium as Na	mg/L	APHA 3500-Na B	64	Not Specified
14.	Magnesium as Mg	mg/L	APHA 3500-Mg B	12.63	Not Specified
15.	Calcium as Ca	mg/L	APHA3500-Ca	27.2	Not Specified
16.	Total Hardness as CaCO3	mg/L	APHA2340 C	120	Not Specified
17.	Free Ammonia	mg/L	APHA 4500-NH3 F	0.16	5.0
18.	Chloride as CI	mg/L	APHA 4500-CI-B	70.44	Not Specified
19.	Sulphate as SO4	mg/L	APHA4500-SO42-E	24.46	Not Specified
20.	Fluoride as F	mg/L	APHA 4500F D	0.12	2.0
21.	P-Alkalinity as CaCO3	mg/L	APHA 2320 B	32.0	Not Specified
22.	Dissolved Phosphate	mg/L	APHA4500-P D	0.21	5.0
23.	Ammonical Nitrogen	MPL Index/100ml	APHA 9221 A, B, C, D, E & F	1.49	50
24.	Total Alkalinity as CaCO3	mg/L	APHA2320 B	156	Not Specified
25.	Faecal coliform			150	Not Specified
26.	Total coliform			2100	Not Specified
BOD-Biochemical Oxygen Demand					
INFERENCE	As per the General standards prescribed in the Environmental (Protection) Rules, 1986 for discharge of Environmental Pollutants Part-A: Effluents for Inland Surface Water – The measured values for the above parameters for those standards have been specified, were observed to be within the said standard				

1. Name of the Location : Jack Well at Bellanduru Pump House
2. GPS Location of Monitoring : 12° 56'31.18" N, 77° 43' 07.77" E
3. Name of the Project : Continuous checking of water quality of secondary treated water at STP inlet point of Bellanduru Lake and tanks of Kolar & Chikkaballpur Districts.
4. Sample Collected by : M/s. Environmental Health and Safety Research & Development Centre, Bengaluru- 560 010.
5. Date of collection : 26.12.2019
6. Particulars of Sample Collected : Surface water, Grab Sampling
7. Date of sample Receipt : 27.12.2019
8. Sample Number: EHSRDC/KC/W/19/12/11111
9. Protocol: APHA, 23rd Edition

Table 7: Water analysis of Jack Well at Bellanduru Pump House

Sl.					
No	Unit	Test Methods	Results	Standards prescribed for Inland surface Water	
1.	pH	-	APHA 4500H* B	7.57	5.5-9.0
2.	Electrical Conductivity	us/cm	APHA 2510 B	1155	Not Specified
3.	Turbidity	NTU	APHA2130 B	1.05	Not Specified
4.	Dissolved Oxygen	mg/L	APHA 4500-0 C	5.0	Not Specified
5.	Total Dissolved Solids	mg/L	APHA 2540 C	939	Not Specified

6.	Total Fixed Solids	mg/L	APHA 2540 C	510	Not Specified
7.	Suspended Solids	mg/L	APHA 2540 D	17	100
8.	Chemical Oxygen Demand	mg/L	APHA 5220 B	38.4	250
9.	BOD (3 Days @27°C)	mg/L	APHA 5210 B	9.0	30
10.	Nitrate Nitrogen as NO3-N	mg/L	APHA 4500-NO3 E	4.49	10
11.	Boron as B	mg/L	APHA 4500-B B	0.19	Not Specified
12.	Potassium as K	mg/L	APHA 3500-K	12	Not Specified
13.	Sodium as Na	mg/L	APHA 3500-Na B	80	Not Specified
14.	Magnesium as Mg	mg/L	APHA 3500-Mg B	20.41	Not Specified
15.	Calcium as Ca	mg/L	APHA3500-Ca	52.8	Not Specified
16.	Total Hardness as CaCO3	mg/L	APHA2340 C	216	Not Specified
17.	Free Ammonia	mg/L	APHA 4500-NH3 F	0.10	5.0
18.	Chloride as CI	mg/L	APHA 4500-CI-B	123.28	Not Specified
19.	Sulphate as SO4	mg/L	APHA4500-SO42-E	60.98	Not Specified
20.	Fluoride as F	mg/L	APHA 4500F D	0.41	2.0
21.	P-Alkalinity as CaCO3	mg/L	APHA 2320 B	BDL	Not Specified
22.	Dissolved Phosphate	mg/L	APHA4500-P D	0.47	5.0
23.	Ammonical Nitrogen	mg/L	APHA 4500-NH3 B C	13.38	50
24.	Total Alkalinity as CaCO3	mg/L	APHA2320 B	96	Not Specified
25.	Faecal coliform			220	Not Specified
26.	Total coliform			2400	Not Specified
BOD-Biochemical Oxygen Demand					
INFERENCE	As per the General standards prescribed in the Environmental (Protection) Rules, 1986 for discharge of Environmental Pollutants Part-A: Effluents for Inland Surface Water – The measured values for the above parameters for those standards have been specified, were observed to be within the said standard				

Recycling of sludge/silt from the Varthur and Bellanduru lakes

The silt / sludge samples at 4 locations (3 sub samples, at top, middle and bottom in each location) in Varthur lake and 3 locations (top soil and at 2 feet depth) in Bellanduru lake were collected and got analyzed for heavy metals from Central Pollution Control Board (CPCB) Tables-8 and 9.

Table 8: Test Result: Sediment of Varthur Lake

Sampling Location:	Varthur Lake, Bengaluru
Nature of Sample:	Sediment Sample
Sampling Type:	Grab
Date of Sampling	18.01.2020
Date of receipt	11.02.2020
Refernce method	APHA3120-B23rd Edition2017

		Sample 1		Sample 2		Sample 3		Sample 4				
Sl No.	**Metal (mg/kg)**	**1- Top Soil, Varthur Lake**	**1a- Below Ground level (2feet), Varthur Lake**	**2- Top Varthur Lake**	**2a- Below Ground level (2feet), Varthur Lake**	**3- Top Varthur Lake**	**3a- Below Ground level (2feet), Varthur Lake**	**4- Top Varthur Lake**	**4a- Below Ground level (2feet), Varthur Lake**	**4b- Below Ground Level (5Feet), Varthur Lake**	**Blank**	**Detection Limit**
1.	Copper	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.1**
2.	Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.1**
3.	Total Chromium	26	BDL	54	38	44	38	BDL	68	BDL	BDL	**0.1**
4.	Iron	17726	19214	44460	30180	29420	29720	8814	34460	6440	512	**0.1**
5.	Manganese	48	226	98	192	154	200	40	866	52	BDL	**0.1**
6.	Nickel	BDL	BDL	20	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.1**
7.	Lead	BDL	80	BDL	56	BDL	BDL	BDL	264	BDL	BDL	**0.1**
8.	Zinc	52	90	BDL	24	68	28	42	48	BDL	BDL	**0.1**
9.	Colour											**Brown to Black**
10.	Odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	**Absence of foul odour**
11.	Moisture %byweight Maxium	_	_	_	_	_	_	_	_	_	_	**25**
12.	pH	_	_	_	_	_	_	_	_	_	_	**6.5-7.5**

13.	Conductivity(as dsm') not more that	_	_	_	_	_	_	_	_	_	_	**4**
14.	Total organic carbon (%)by wt minimum	13.87	46.3	19.12	13.51	9.08	27.45	34.7	29.12	19.27	_	**18**
15.	Total nitrogen(as N) % by wt minimum	1.28	0.76	1.61	0.69	0.57	0.79	0.89	0.29	0.66	_	**1**
16.	Total phosphorous (as P2O5)% by wt Min	0.1	0.15	0.17	0.1	0.31	0.25	0.19	0.01	0.04	_	**0.8**
17.	Total potash(as K2O)%by wt minimum	0.37	0.37	0.3	0.31	0.2	0.19	0.15	0.39	0.09	_	**0.8**
18.	C.N.Ratio	11:01	#####	12:01	20:01	16:01	#####	#####	#####	#####	_	**<20**
19.	Bulk denstiy maximum	_	_	_	_	_	_	_	_	_	_	**0.7-0.9**
20.	Partical size after pasing through 4mm IS sieve min	_	_	_	_	_	_	_	_	_	_	**Not less than 75%**
21.	Iron(mg/kg)	_	_	_	_	_	_	_	_	_	_	_
22.	Manganese(mg/kg)	_	_	_	_	_	_	_	_	_	_	_
23.	Copper(mg/kg),Max	_	_	_	_	_	_	_	_	_	_	**300**
24.	Zinc(mg/kg),Max	_	_	_	_	_	_	_	_	_	_	**1000**

25.	Lead(mg/kg),Max	_	_	_	_	_	_	_	_	_	_	**100**
26.	Cadmium(mg/kg),Max	_	_	_	_	_	_	_	_	_	_	**5**
27.	Chromium(mg/kg),max	_	_	_	_	_	_	_	_	_	_	**50**
28.	Nickel (mg/kg) max	_	_	_	_	_	_	_	_	_	_	**50**
29.	Calcium % by wt	_	_	_	_	_	_	_	_	_	_	_
30.	Magnesium % by weight	_	_	_	_	_	_	_	_	_	_	_

Note: Serial no 1-8 have been analysed by CPCB lab and 9-23 analysed at horticulture department

Table-9,Test Result: Sediment of Balladur Lake

Balladur Lake, Bengaluru: Sampling Location
Sediment Sample: Nature of Sample
Grab : Sampling Type
18.01.2020: Date of Sampling
11.02.2020 - 12.02.2020
12.02.2020: Date of receipt
APHA 3120-B 23rd Edition 2017

		Near Y Junction next to the drain carrying sewage,Bellandur Lake Bengaluru			**Middle of the Bellandur Lake, Bengaluru**			**Bellandur Lake Near Kodi, Bengaluru**			**Standrads**
Sl No	**Metal (mg/kg)**	**2- Top**	**2A-Middle**	**2B-Bottom**	**4 - Top**	**4A - Middle**	**4B -Bottom**	**5 - Top**	**5A - Middle**	**5B -Bottom**	
1.	Copper	80	68	26	688	286	BDL	290	312	BDL	**0.1**
2.	Cadmium	BDL	BDL	BDL	80	BDL	BDL	BDL	BDL	BDL	**0.1**
3.	Total Chromium	46	22	BDL	196	80	BDL	132	118	74	**0.1**

4.	Iron	19312	11806	8244	35480	24200	3166	25460	23680	62780	**0.1**
5.	Manganese	110	96	58	212	234	BDL	174	314	226	**0.1**
6.	Nickel	BDL	BDL	BDL	58	BDL	BDL	56	72	28	**0.1**
7.	Lead	38	BDL	BDL	92	30	BDL	48	78	BDL	**0.1**
8.	Zinc	242	126	72	1576	666	BDL	908	790	68	**0.1**
9.	Colour										**Brown to Black**
10.	Odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	No foul odour	**Absence of foul odour**
11.	Moisture %by-weight Maxium	_	_	_	_	_	_	_	_	_	**25**
12.	pH	_	_	_	_	_	_	_	_	_	**6.5-7.5**
13.	Conductivity(as dsm')not more that	_	_	_	_	_	_	_	_	_	**4**
14.	Total organic carbon (%)by wt minimum	7.08	4.92	3.18	66.3	13.51	3.82	22.13	19.13	0.92	**18**
15.	Total nitrogen(as N) % by wt minimum	0.44	0.14	0.15	0.19	0.38	0.42	2	1.41	0.49	**1**
16.	Total phosphorous (as P2O5)% by wt Min	0.3	0.19	0.18	0.44	0.51	0.04	0.28	0.57	0.14	**0.8**
17.	Total potash(as K2O)%by wt minimum	0.15	0.1	0.12	0.26	0.25	0.1	0.21	0.29	0.09	**0.8**
18.	C.N.Ratio	16:01	36:01:00	21:01	349:01:00	36:01:00	09:01	11:01	14:01	02:01	**<20**
19.	Bulk denstiy maximum	_	_	_	_	_	_	_	_	_	**0.7-0.9**
20.	Partical size after pasing through 4mm IS sieve min	_	_	_	_	_	_	_	_	_	**Not less than 75%**
21.	Iron(mg/kg)	_	_	_	_	_	_	_	_	_	_
22.	Manganese(mg/kg)	_	_	_	_	_	_	_	_	_	_
23.	Copper(mg/kg),-Max	_	_	_	_	_	_	_	_	_	**300**
24.	Zinc(mg/kg),Max	_	_	_	_	_	_	_	_	_	**1000**
25.	Lead(mg/kg),Max	_	_	_	_	_	_	_	_	_	**100**
26.	Cadmium(mg/kg),Max	_	_	_	_	_	_	_	_	_	**5**

27.	Chromium(mg/kg),max	_	_	_	_	_	_	_	_	_	**50**
28.	Nickel (mg/kg) max	_	_	_	_	_	_	_	_	_	**50**
29.	Calcium % by wt	_	_	_	_	_	_	_	_	_	_
30.	Magnesium % by weight	_	_	_	_	_	_	_	_	_	_

The CPCB was requested to give its view in regard to use the sludge/silt for agriculture/ horticulture purposes. The recommendations of CPCB in the matter are as under:
The results indicated that the sediments of Bellandur Lake (three out of five locations) has heavy metal values above the response level and required to be disposed accordingly. At Varthur Lake, at all locations (3 Nos) the values reported for heavy metals are lesser than response levels. The disposal methods of sediments may be further evaluated based on compost quality as per Solid Waste Management Rules 2016 and Screening level values for heavy metals.

The Guidelines for evaluation of MSW Landfills as per Solid Waste Management Rules, 2016 may be the most suitable option and technology for disposal of sediments. The Central Public Health and Environmental Engineering Organization Manual may also be referred for guidance. The use of sludge/silt from Belandure lake is ruled out due to heavy metals. Accordingly, it is not recycled.

However, in case of Varthure lake, some farmers have used the sludge/silt as manure and results are very encouraging. One farmer by name Shri Venkata Reddy who have used the sludge/silt in his farm has shared his experience and photographs.

Recycling of sewage from Industries and Apartments

In particular to K&C Valley catchment area, totally there were 490 industries (Red, Orange & Green category) out of which water-based industries were 99 and total quantity of trade effluent generated from these 99 industries was around 3.6 MLD and sewage was around 4.9 MLD. Further, the sewage generated from these industries were treated either in STP/Septic tank & Soak pit or discharged to BWSSB sewers/UGD. These units are being regularly monitored to keep a close watch on these units and also conducting joint inspection.

Zero Liquid Discharge (ZLD) is a wastewater treatment principle to completely eliminate all liquid discharge from a system. But in practice this does not taking place and require much more to be done in this direction. All the units which treat and reuse all the wastewater completely within their premises are considered as ZLD units.

The abstract of these 99 industries are as below:

Sl No	Present status of industries	Nos.
1	Adopted ZLD-Provided ETP & reusing treated effluent within the premises	30
2	Adopted Dry washing of vehicles by automobile service stations	23
3	Closed	15
4	Handing over to CETP	21
5	In house centralized STP and	
Handing over to CSTP	03	
6	Activity changed and no generation of effluent	06
7	Provided ETP & Discharging treated effluent outside the premises (into UGD by Bangalore Diary-BAMUL)	01
Total		**99**

For infrastructure projects such as Commercial Complexes, Apartments, etc. other than Industries:

Presently, the Discharge Standards for Sewage Treatment Plant (treated sewage quality standards) are evolved by Central Pollution Control Board for reusing it for non-potable/secondary purposes such as gardening, toilet flushing, car washing and cooling purpose as under:

Sl.no	Parameter	Parameters Limit
1.	pH	6.5-9.0
2.	BOD (mg/l)	Not more than 10
3.	COD (mg/l)	Not more than 50
4.	TSS (mg/l)	Not more than 20
5.	NH4-N (mg/l)	Not more than 5
6.	N-Total (mg/l)	Not more than 10
7.	Fecal Coliform (MPN/100 ml)	Less than 100

However, there may be excess treated sewage even after re-using the treated sewage for secondary purposes. Hence, 100% recycling of treated sewage within the premises and making the apartments/ townships or institutions a Zero liquid discharge concept is found to be not feasible.

In regard to the generation of sewage by the 873 apartments located in the catchment area of the lakes in K&C Valley, 82.825 MLD is generated by these Apartments. Out of the 873 units, 496 units have the STP & treat about 62.223 MLD and recycle/reuse for gardening, flushing toilets, washing of vehicles and watering road side plants. The treated water shall also be make use for maintaining the water level of developed lakes. About 13.256 MLD generated by 272 units are allowing the sewage into the Under-Ground Drainage (UGD). 51 units generate about 4.998 MLD are in the process of construction of STP. Another 38 units generate 1.721 MLD have agreed to setup the STP. 16 units are not co-operating in the process of installation of STP and the sewage of 0.627 MLD are let into the open drains. In total about 7.345 MLD is being let into the open drains. Defaulters may be acted upon under the provisions of Water Act 1974.

Acknowledgements

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