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Assessment and Control Measures for Jayanti Stream to Control Water Pollution of Panchganga River, Maharashtra, India

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***Abstract* - Water pollution is one of the most leading causes of public health issues and mortality. It is mainly the outcome of urbanization and overpopulation and is caused due to over utilization of fertilizers by farmers, sewage from hotels, hospitals and homes and industries in the city. Present paper is a case study of Kolhapur city in Maharashtra. In this paper, an attempt has been made to understand the problem of water pollution of panchaganga river due to urbanization and industrialization and its impact on public health in Kolhapur city. As more than half the polluted water comes from the jayanti stream to the panchganga river so jayanti stream has been considered as the major point of research and an innovative concept is suggested to deal with this problem effectively. The polluted water of Panchganga has led to spread some dangerous infectious diseases like Diarrhea, jaundice, gastro and fever etc. in Kolhapur city. Therefore; there is a need of government intervention with the help of active peoples' participation.**

***Keywords* – Urbanization; mortality; Industrialization.**

I. INTRODUCTION

Kolhapur is the adjacent urban body located along the bank of the river with a population of 549283 and this city is located at 16° 42' N and 74° 14' E, having mean sea level of 570 m.

Area of Kolhapur city is around 6682 Ha. Panchganga flows from the borders of Kolhapur. It originates in Western ghats and is a major tributary to Krishna. It starts from Prayag Sangam. The Panchganga is formed, by four streams, the Kasari, the Kumbhi, the Tulsi and the Bhogawati. One more river stream Saraswati is believed to flow underground and together with the other four streams make river Panchganga.

The Prayag Sangam confluence marks the beginning of the Panchganga River which after receiving the waters of the four tributaries continues in a larger pattern with the flow of waters received from the rivers. From North of Kolhapur it has a wide alluvial plain. After developing this plain the river resumes its course eastwards. From Kolhapur the Panchganga River, flows east about forty five kms. till its falls into the Krishna at Kurundvad. During its course to the east of Kolhapur, the Panchaganga River receives considerable streams of nallas within Kolhapur and Ichalkaranji.

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Fig 1. River streams in Kolhapur District

The nallas like Jayanti, Dudhali, Line Bazar, Raman Mala, Rajhans in Klhapurand Kabnur, Chandur, Tilavani, Talange and Kala odha in Ichalkaranji carries significant volume of treated and untreated domestic wastewater and waste from Textile industries (CETP) and joins the Panchganga River. The inadequate domestic wastewater treatment facilities have resulted in increase in pollution resulting in serious the health impacts. High incidents of Jaundice and other diseases were recorded since 2011. Though the attempts have been made to minimize the pollution, significant improvement is expected only when new STPs and sewer lines for collection of sewage are functional.

However, there was delay in construction and implementation of new STP at Kasba Bawada, Kolhapur and river water quality was not meeting the stipulated standards due to discharge of untreated wastewater. In the year 2012, more than 500 new cases of Jaundice were reported from the textile town of Ichalkaranji in Kolhapur district and many deaths were recorded. Kolhapur health department suspects that the consumption of contaminated water of Panchganag River by people is the cause behind the recent epidemic of Jaundice in Ichalkaranji. In May-June 2012, schools were declared closed for some time.

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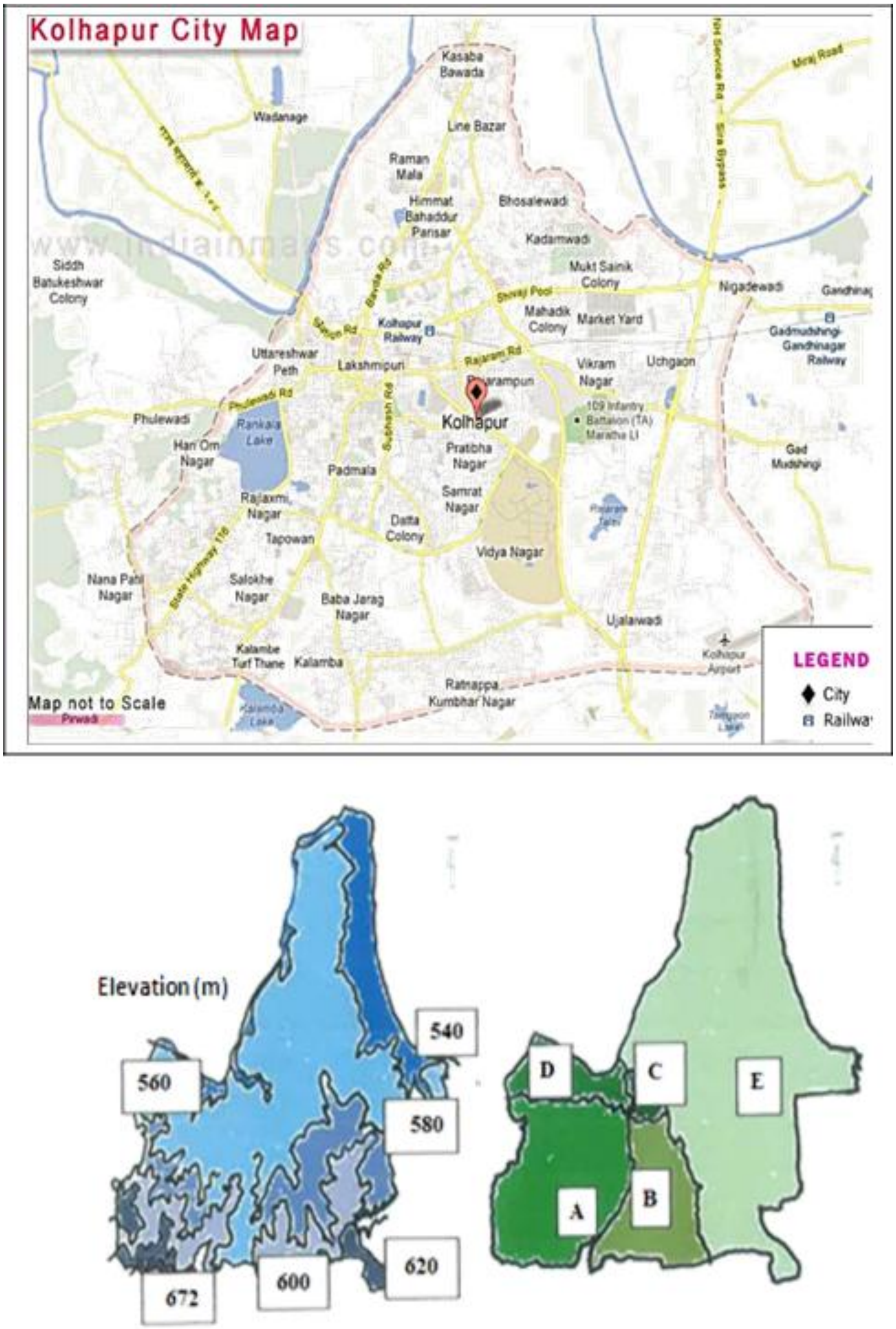

Fig 2. Kolhapur City

II. Scope Of Work

- Collection of secondary data for existing situation of water quality, wastewater systems as a whole.
- Reconnaissance survey of the river for the affected stretches as also upstream
- Assessment of water quality of the river as also all natural streams which are converted into nalla carrying wastewater.
- Suggest remedial measures to restore and maintain the river ecology for its designated use.
- Finalize the appropriate monitoring stations in the identified river stretch and work plan for regular monitoring.
- Evaluation of existing Sewage Treatment Plants.
- Methods for recycle and reuse of treated effluents from wastewater treatment plants.

III. Records Of Nalla Flows In Kolhapur

The information on nallas which directly joins the river, their flow details is given in Table 1. Following figures shows the photographs of different nallas received the waste water at Kolhapur City.

Table 1:
Nallas at Kolhapur with Flow Details Directly Discharging Sewage in the River (MLD)

Sr.	Name of the Nalla	Flow (MLD)	Length (km)	Status of
1	Jayanti stream	0*	9	Sewered
2	Dudhali	5	2	30 % Sewered
3	Jamdar	0.4	4	
4	Sidhharth Nagar	0.1	1	
5	CPR	0.5	1.5	Sewered
6	Rajhans	1	1.2	Sewered
7	Ramanmala	1	1.8	Sewered
8	Dream world	0.4	1.4	Unsewered
9	Line Bazaar	3	1.3	Unsewered
10	Kasba Bawda Treated Effluent	0.2		Unsewered
11	Vithbhatti Nalla	0.5		

* *Arrangements are made to stop the flow by constructing bunds and lifting nalla water to STP*

[Source : Kolhapur Municipal Corporation]

3.1 Description of nallas

3.1.1 Jayanti Stream **:** Kalamba lake overflows is the original starting point of Jayanti nalla. At Hutatma park, Gomati nalla mixes Jayanti nalla to form a big nalla basin. It receives sewage from nearby areas. It is the largest catchment and accounts for more than 60% of the total sewage generated in the city. A small tannery belt is also located in the basins which discharge the waste in nalla. At present a bund has been constructed on Jayanti nalla near Shahu Maratha pumping station.

Hence the sewage flowing through Jayanti nalla is pumped to this pumping station and is eventually sent to STP at Kasba Bawda. An attempt has been made to treat the wastewater flowing through nalla using chlorine dosing. Though all the sewage flowing upstream to bund is being pumped from Jayanti nalla, two more nallas meet Jayanti nalla basin downstream the bund. These nallas include CPR nalla and Budhwar Peth nalla. CPR nalla receives sewage from CPR hospital and other areas like Town Hall, Sonya Maruti Chouk,Shaniwar Peth, Burud galli etc.

3.1.2 Dudhali Nalla: Dudahali nalla comprises of many small drains and gutters. This nalla receives sewage from areas near Rankala tank, Lakshateerth, parts of areas in Ravawar and Shankar. From Shivaji Peth onwards this Nalla becomes larger Dudhali nalla receives the overflow of Rankala lake water throughout the year which is approx. 5 MLD.

The effectiveness of chlorination has not been tested for reduction of microbial population. The time taken by these chlorinated nalla flows to reach river stretch is inadequate to confirm the contact time of 30 minutes for evaluation of chlorination treatment. Laboratory experiments should be conducted to decide the chlorine dose and reduction in coliforms.

Chlorination at Jayanti Nalla

Jayanti Nalla after meeting CPR Nalla

Line Bazaar Nalla

Rajaram Nalla

Bapat Camp Nalla | Dudhali Nalla | Chlorination at Raman Mala

Figure 3: Different Nallas at Kolhapur City

At present a temporary bund is constructed across Dudhali nalla just before the nalla meets river. At the bund, some part of the sewage is pumped to Dudhali nalla pumping station and is pumped to Shahu Maharaj pumping station and is finally sent to STP at Kasba Bawada. Bleaching powder dose is applied to the wastewater flowing through this nalla. A small portion of sewage from nalla is used for irrigation near the pumping station.

3.1.3 Line Bazar Nalla Basin: At present sewage from Kasba Bawda flows through this nalla. The nalla joins the river upstream of the intake well in the river Panchganga which supplies water to Bawda Water treatment plant. A large portion of land between Kasba Bawda locality and the river is used for agriculture. Significant portion of sewage generated in this area is used for irrigation.

3.1.4 Bapat Camp Nalla (Kawala Naka Nalla): Sewage generated in the region present in the catchment of Bapat camp nalla flows through this nalla. The nalla is quite narrow at a distance of about 250m upstream of confluence with the river. Another nalla called Kawla Naka Nalla carrying major part of domestic sewage of the city meets Bapat camp nalla. Main Bapat camp nalla carries discharge for sewage treatment plant at Kasba Bawda. A large portion of sewage flowing through Bapat camp nalla is being used for irrigation by installation of pumps in the nalla.

3.2 Quantification and Flow Estimation of Nallas

Surface water flow is the continuous movement of water in runoff or open channels.

This flow is quantified as discharge and is defined as the rate of flow or the volume of water that passes through a channel cross section in a specific period of time.

Discharge can be reported as total volume (e.g., acre-feet or millions of gallons) or as a rate such as cubic feet per second (ft3/s) or cubic meters per second.

Objectives of nalla flow estimation:

- To quantify the flow entering the river through nallas
- To suggest appropriate treatment technology and evaluate the adequacy of the proposed Sewerage system.

3.2.1 Methodology: The Nalla flow estimation was done using Ping Pong ball method as prescribed by USEPA. Following steps were carried out while flow measurement.

- Flow measurement of nallas was carried out at for three times in a day i.e.in the morning between 8 to 10 am, in the afternoon between 1 to 3pm and in the evening between 5 to 7 pm to get the approximate flow during the day.
- As the cross section of streams is irregular and flow also varies accordingly, a straight stretch of the nalla was selected to carry out the flow measurement studies. As per the USEPA protocol, the selected stretch should be having minimum length of 20 feet.
- Depth and width were noted at three places in the specified stretch to get the average depth and width.

The time required for a Ping Pong ball to travel the specified distance was noted using stopwatch.

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Flow measurement at Bapat Camp nalla

Flow Measurement at Jayanti nalla

Flow measurement at Rajaram Nalla

Fig 4. Flow measurements at different nallas

The flow rate of the stream was calculated using the following formula, and estimated flows are presented in **Table 2.**

Flow rate= ALC/T

A: Average cross sectional area of stream
L: Length of the selected stretch
C: Correction factor (0.8 for rocky bottom streams or 0.9 for muddy- bottom streams)

- Time taken to travel the particular distance

This is to correct the fact that water at surface travels faster than near the stream bottom due to resistance from gravels, cobble, etc.)

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Table 2:
Estimated Flow at Different Nallas of Kolhapur City

Kolhapur City Nallas	Flow Rate (million litres per hr)			Flow Rate(MLD)	Flow Rate(MLD) as reported by KMC for 2003-04*
	8am-10am	1pm-3pm	5pm-7pm		
Dudhali nalla	3	2.8	5.1	72	15.7
Jayanti nalla	0.8	1.5	1.4	24	70.1
Line bazaar	1	0.74	0.53	15	2.0
Rajaram	1.2	1.3	0.72	21	5.0
Bapat camp	5.5	7.8	5.9	128	3.8
			Total	**260**	**97**

**Flows and Characteristics of sewage in Nalla Basins in Kolhapur Report*

Significant variation in nalla flows is observed during the study. The increase in flow can be attributed to increased water supply and use of ground water by population and also industries. According to the Environmental status report of Kolhapur 2012-13, the total water supply for the city is around 137 MLD. The water sources for Kolhapur city are :Panchganga river (80 mld), Bhogwati (41 mld), Kalamba (8 mld), and borewells (8 mld). The estimated sewage generation would be 110 MLD considering the generation of sewage to be 80% of total water supply. The Excess wastewater generation can be attributed to excess water consumption other than water supplied by KMC.

IV. Panchaganga River Pollution And Public Health Issues In Kolhapur City:

Panchaganga is one of the most polluted rivers in the world. Every day 90 million liters/day waste water produce in Kolhapur. It's capacity is only 25 million liters/day.The present drainage system is 30 years old and should be modified.

Industrial waste water, jayanti and dudhali nails, domestic waste water are the main sources of the panchaganga river pollution. Due to huge amount of waste water KMC got 131 time notices. Every day 165 metric ton/day solid waste produce.

These solid waste directly go to the river because there is no solid waste management facility properly working at present in the city. Besides panchaganga river eight MIDCs, seven sugar factories and 174 gram panchayat villages produce waste water which goes to the river.The causes of panchganga river pollution are industrial waste water, domestic waste water, solid waste, over utilization of fertilizers, hospitals and small businesses like hotels.

4.1 Discharge of large amount of untreated domestic sewage from the city

The river is getting polluted due to discharge of large amount of sewage carried out by four major sewers in the city such as Jayanti nullah, Dudhali nullah, Line Bazaar nullah and Bapat Camp nullah. Since most of the sewage is untreated, it increases the organic load of the river water. The river water becomes highly polluted due to toxicants, bacterial contamination, plastic litters, solid waste, etc.

Panchganga River	Total Population of Kolhapur City (2001 Census)	Water Usage (per day)	Waste water without treatment (per day)
	4.93 Lakhs	120 Million Litres	100 Million Litres

(Panchganga Basin Pollution study MPCB report, 2009)

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4.2 Disposal of Industrial effluents

Panchganga River	Total No. of Industries	Total waste water without Treatment
	2953	18.59302 Million Litre per day

The industrial effluent coming from different small industrial units, foundries spray painting units in Udyamnagar and Tanneries from Jawahar Nagar alters the quality of river water. The ground water quality also changes due to the industrial effluent.

4.3 Sewage from different hospitals, pathological laboratories

There are total 498 hospitals and dispensaries (governmental, semi-governmental and private) and 31 pathological laboratories in Kolhapur city. Only one hospital i.e. Chhtrapati. Pramilaraje Hospital is planning for STP whereas none of the hospitals in Kolhapur city treat its waste water.

The untreated sewage about 1,00,000 liters per day mixes in to the river through nallahs.

4.4 Effluent from other sources

There are about 49 servicing stations in the city which generates 49,000 liters of waste water. The quality of water alters due to oil and grease content, various petrochemicals colors, etc. The waste water coming from slaughter houses and fish markets are having high organic load which is directly discharged into the nearby sewer which finally ends into the river through nullahs. The sources like hotels, restaurants, hawkers, etc. also contribute for water pollution.

Other sources of River Pollution

Sources	Total No.	Total amount of waste generated
Servicing Stations	41	2,00,000 liters/ day
Hotels, restaurants and hawkers	1044	1,49,400 liters/ day
Slaughter houses waste	02	800 Kg/ day
Meat shops and Fish	76	1000 Kg/ day

4.5 Agro – chemicals used in the fields

Large quantities of agrochemicals are used in the agricultural sector in the upstream as well as in surrounding areas of the river. The residues of these chemicals mix in to the river due to excess use, flooding, heavy rainfall, excess irrigation, etc.

Many pesticides and chemicals when dissolved in the river water enter in the food chain. Studies have shown that many vegetables and fruits contain harmful residue of agrochemicals.

Sr. No	Type of Agro - chemical	Solid State (per year)	Liquid State (per year)
1	Chemical fertilizers	78,244 Tones	
2	Pesticides	1,41,764 Tones	22,068 Litres
3	Weedicides	34,995 Tones	21,664 Liters
4	Fungicides	6771 Tones	1828 Liters

4.6 Crematorium ash:

Crematorium ash is becoming one of the reasons of water pollution. There are about four crematorium sites present in the city. Each year approximately 130 tones of crematorium ash pollutes the river water. The crematorium which is most affecting the quality of river water is Vaishvadham Crematorium located near Prince Shivaji Bridge and Bapat Camp crematorium. After burning of the dead bodies, as a ritual, the ash is disposed in the river water, which forms a layer on water surface.

It traps the sunlight and prevents mixing of oxygen into the water. There is change in the physicochemical parameters of the water body. The amount of total solids, total dissolved solids, toxic heavy metals, phosphate and nitrate level increases. At the same time, amount of dissolved oxygen decreases. The aquatic ecosystem gets harmed as well as water becomes unsuitable for drinking purpose. The downstream areas of the river also get affected as well as the aesthetic beauty of the site decreases.

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4.7 Religious activities:

Various religious activities during festivals produce solid waste in the form of nirmalya and idols.

The idols made up of Plaster of Paris changes the physicochemical composition of water body. There are 12 sites in the city where the Nirmanlya and idols are disposed.

Sr. No	Components Amount per year	Amount per 90 tonnes
1	Nirmalaya	90 Tonnes
2	Idols (domestic)	27000
3	Idols (Sarvajanik)	600

The idols are made up of Plaster of Paris or Shadoo and coloured with chemicals. When these idols immersed in water the chemicals dissolve in water body altering water quality. Thepaints are having heavy metals such as copper, zinc, lead, chromium and iron. The other constituents of the idol like bamboo, flowers, cotton, clothes and other pollutants such as eatables like prasad, coir, plastic, etc increase the nutrients in the lake and lead to eutrophication. The water column is disturbed completely during idol immersion.

4.8 Discharge of nullahs in the river basin:

There are four nullahs in the city viz. Jayanti Nullah, Dudhali Nullah, Line Bazaar nullah and Bapat Camp Nullah. Jayanti nullah starts flowing from eastern part of the city. During its course through the heart of the city, it receives waste water from tanneries from Jawahar Nagar, domestic waste from the city, effluent from fabrication units, spray painting units and foundries from Udyamnagar. Jayanti nullah basin covers 2357 ha of the city.

Patients suffering from water – borne diseases

Year	Jaundice	Diarrhea	Dysentery	Gastro	Other
2005 - 06	146	221	48	223	15
2006 - 07	85	298	84	132	23
2007 - 08	103	320	94	51	10
2008 - 09	139	241	79	79	7
Total	473	1090	305	485	55

V. Current Scenario Of Water Treatment Plants In Kolhapur

At present water is supplied to Kolhapur city through water treatment plants:-

Kolhapur Municipal Corporation has provided four water treatment plants for serving potable and safe drinking water to the citizens. These are namely; Kalamba water treatment plant, Puikhadi water treatment plant, Bawda water treatment plant and Balinga water treatment plant.

• *Kalamba water treatment plant:* **-** It is the oldest water treatment plant and started in pre independence days. An earthen dam about 4300 ft. long and 27 ft. high was constructed during 1881- 83 on the southern side of the city. The treatment plant is of 8 MLD capacity. The water of the Kalamba tank is pure and wholesome and is filtered and chlorinated. Kalamba water is available only to a portion of the city i.e to B ward.

• *Puikhadi water treatment plant:* - This treatment plant is located at Puikhadi, 14 km. away from the Shingnapur pumping station. This plant is recent plant established by KMC and started functioning in the year 2001. The capacity of this plant is 50 MLD.

• *Bawada water treatment plant:* - This water works is commissioned in the year 1978. It is located 5 km away from Bawada pumping station. Initially the treated water from this plant was served to E ward and to 6 villages of eastern outskirts of city. The capacity of this plant is 36 MLD and presently this supplies water to E ward only.

• *Balinga water treatment plant:*- This water works commissioned in the year 1949 with the capacity of 10.90 MLD which was increased by providing augmentation schemes. Now the total capacity of this plant is 41 MLD and the source of the water from Bhogawati river.

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Parameter	Kalamba WTP		Puikhadi WTP		Bawda WTP		Balinga WTP		WHO standards
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	
pH	7.78	7.74	7.31	7.36	7.2	7.08	7.02	7.10	6.5-8.5
Turbidity (NTU)	20.3	4.4	21.6	4.6	26.6	4.3	24.31	4.9	5-25
Hardness	154	124	76	60	68	52	84	60	100-500
Chloride	25.7	17.04	25.56	20.1	51.12	30.1	48.2	19.22	20-500
TDS	200	110	245	135	505	100	400	100	500-1000
MPN	1600>	nil	1600>	nil	1600>	nil	1600>	nil	0/100 ml

(Dept. of Environmental Science, SUK) (All the parameters except pH, MPN and turbidity are expressed in mg/l)

The results of the treated drinking water in the WTP are within the standard limits but further analysis of piped water shows presence of coli form bacteria due to leakages in the system.

VI. Recommendations

6.1 Rejuvenating a stream

This solution is not just regarding treating of the waste water but it is moreover a concept of rejuvenating a stream i.e. making the ecosystem alive. The process of making the ecosystem alive is not a time bound concept, but its a process which goes on years to years to form that certain ecological cycle. The main ideology of this proposed concept is not only to make the stream pollution free but also to make the surrounding environment clean and hygienic and to re-invent the stream with all the aquatic life.

The main problems with the jayanti streams are the huge amount of plastic waste and other waste materials flowing with water or stagnated at one side. Another problem is land encroachment which is been taking place due to increased population due to which the width of the stream is even getting reduced day-by-day. Due to direct discharge of the sewage water into the stream the jayanti stream is getting polluted and due to which the entire ecosystem is getting hampered.

So, In this concept certain arrangements are done to primarily treat the waste water which is being released from the residential spaces and also to collect the plastic waste and other waste materials flowing with the water so as to make the flow of water circulated within the entire city without of the clogging of waste.

6.1.1 Soil washing – The flow of waste water through the stream have made the bed level contaminated due to which the 0.20 metres of top layer of soil have become infertile. Now, this infertile layer of soil obstructs the growth of aquatic plants. So, a top layer of about 0.20 to 0.30m is taken off and soil washing is done. Soil washing is an ex-situ remediation technique that removes hazardous contaminants from soil by washing the soil with a liquid (often with a chemical additive), scrubbing the soil, and then separating the clean soils from contaminated soil and washwater. The concept of soil washing is based on the theory that contaminants are prone to bind to fine grained soils (silts and clays), which, in turn, are prone to bind to coarse grained soils. Therefore the main goal of soil washing is to separate these contaminated fines and washwater from the cleaned coarse grained soils (sands and gravels). After the process of soil washing it is then reused to form the bed level of the jayanti stream. Now, soil washing will be done in six different steps –

- Pretreatment
- Separation
- Coarse – grained treatment
- Fine – grained treatment
- Process water treatment
- Residuals management

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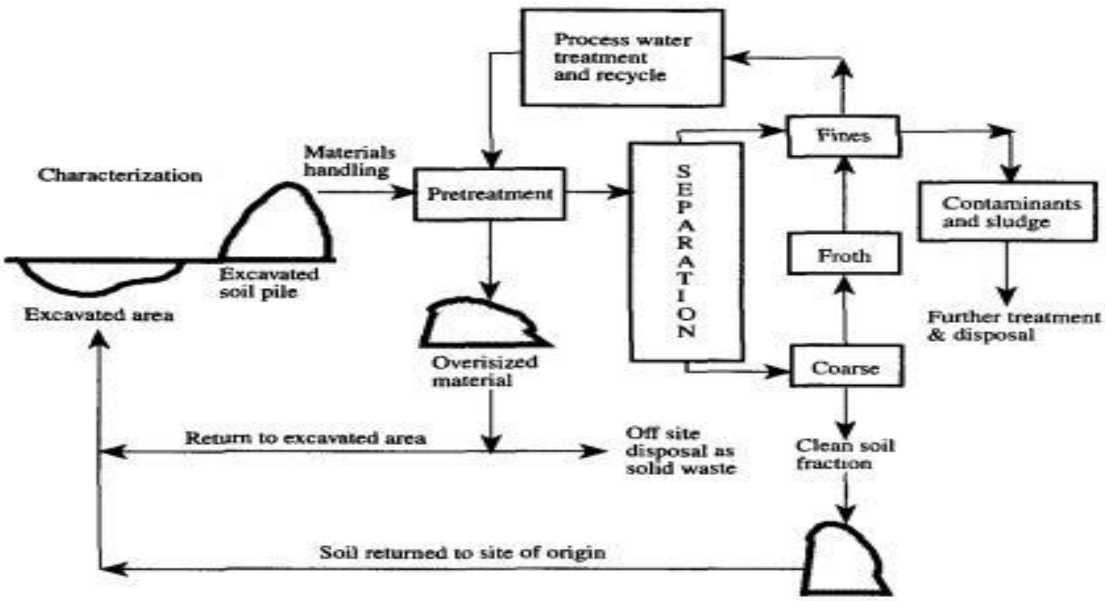


Fig 5. Schematic view of soil washing process

6.1.2 Construction of certain stream amenities

After the soil washing process is completed, the washed soil is then laid on the bed level of the stream. A total of 6 loops are been constructed along the sides of the stream i.e. 3 on one side and remaining 3 on the other side so as to collect the flowing plastic waste and other waste material.

- *Loops* - These loops are constructed entirely with a combination of partly soil and stone walls to a depth of 6m and a diameter of 4.5m. The consecutive distance between the two loops is 12m. Certain arrangement is done by creating an offset just at the entrance of the loop so that the incoming waste materials in the loops are intact and only the water is evacuated from the gap provided at the entrance. Due to which the loops gets stacked only with the waste materials. Now as these waste materials collected in the loops contains plastic waste, other waste from household and commercial spaces it thus forms a minimal quantity of leachate when it comes in contact with the water. And this leachate contaminates the surrounding soil, so as a result of this geosynthetic clay liner (GCL) is been used used under the loops to break the contact of the leachate and the surrounding soil. And also steel cage of certain diameter is been provided over the GCL so that the plastic waste especially are intact into the block-like structure of steel cage.

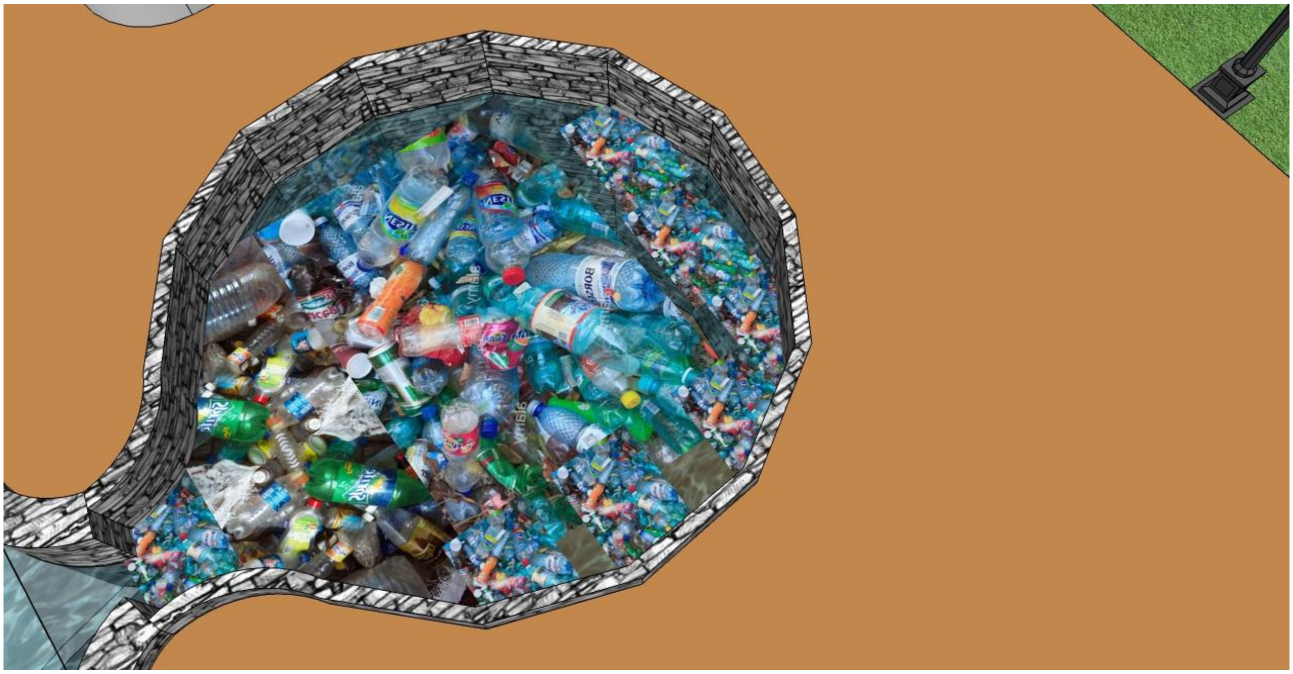
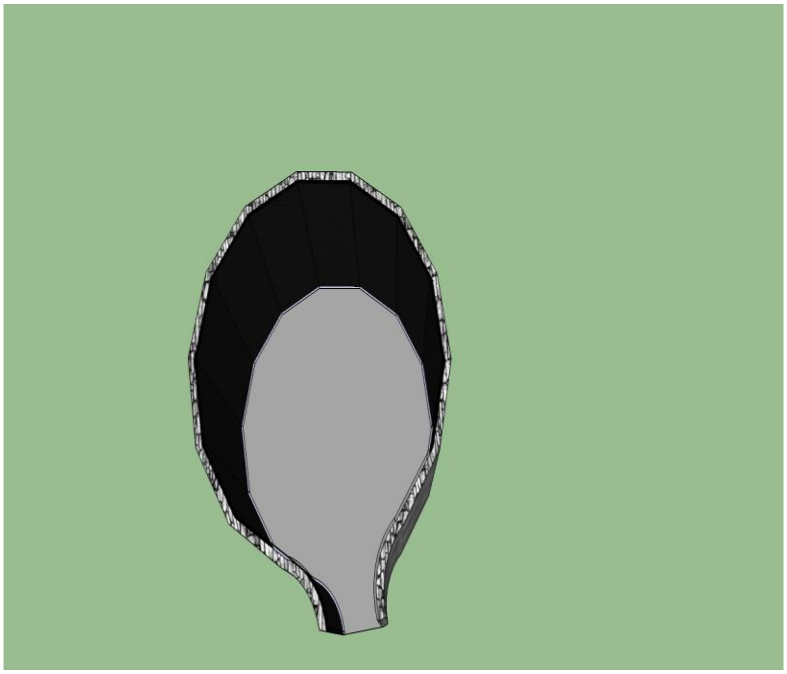


Fig 6. Loops filled with plastic waste and other waste materials



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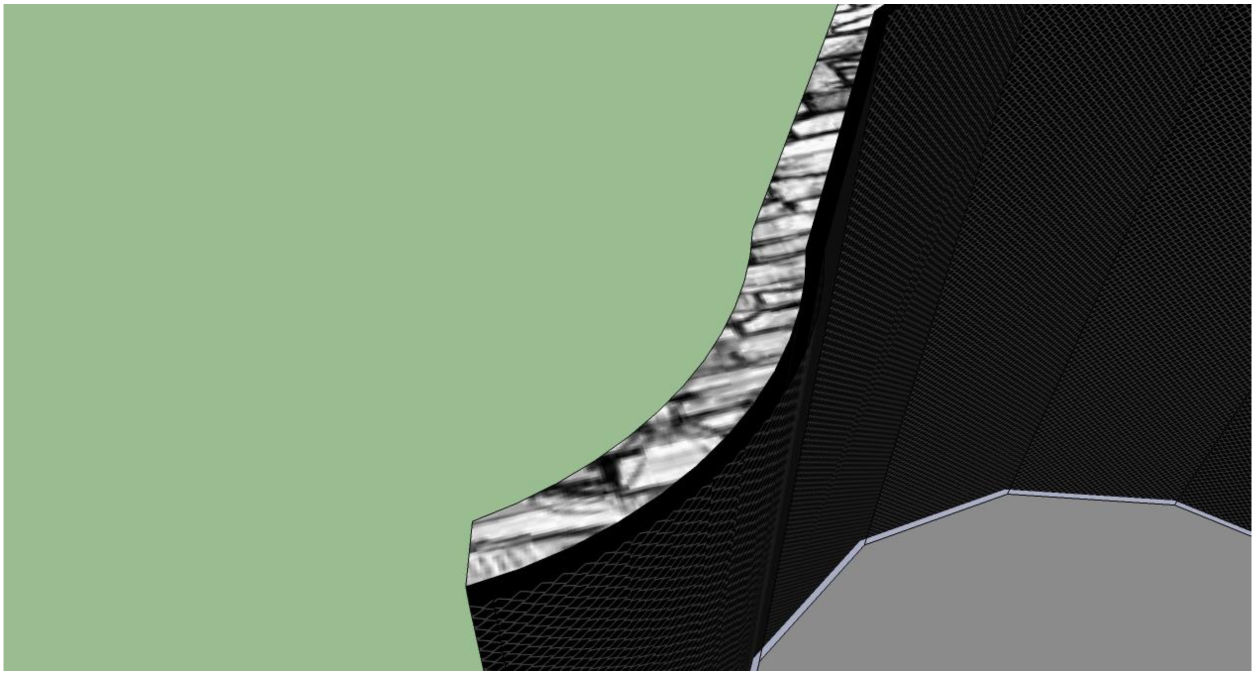

Fig 7(a) 7(b). Loops with Geosynthetic clay liner (GCL) and Steel cage

- *Curtain walls*- are basically constructed with a combination of partly soil and stone with proper grade and profile. These walls are provided so as to prevent side slopes from erosion problem. The entire section with the curtain walls is made straight rather than zig zag so as to have a uniform flow throughout the section and to provide the construction amenities. The height of these walls from the bed level of stream is 5m.
- *Excluders* - Excluders are provided to divert the plastic and other waste materials into the loops. These excluders are constructed with concrete in a curved shape which is connected to the outer edge of the loops. The height of the excluders are 2m from the bed level of the stream.

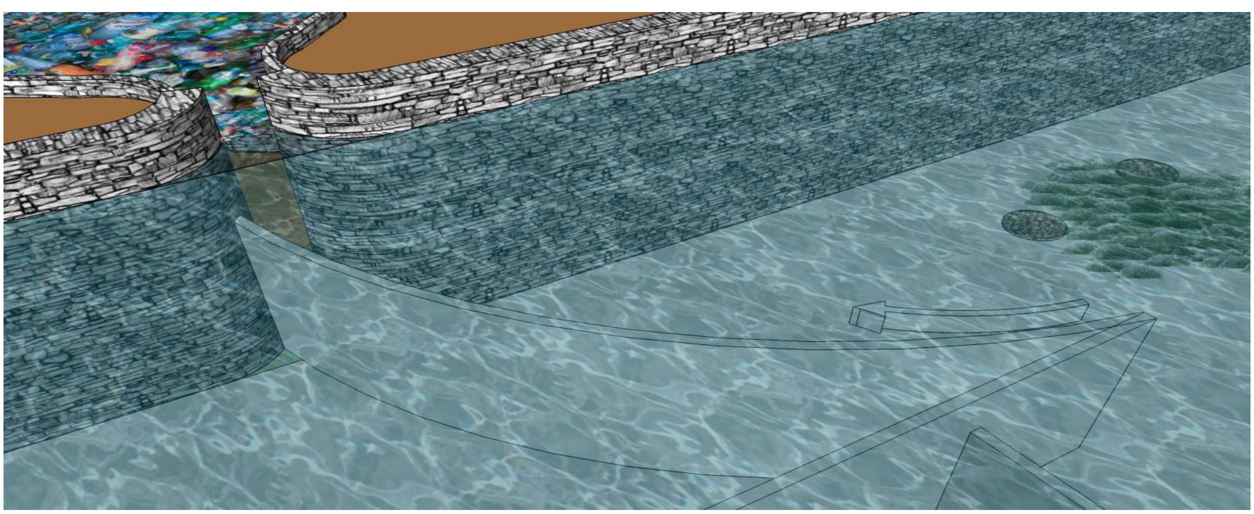

Fig 8. Excluders connected to the outer edge of the loop

- *Check dams* - Check dams are provided with 30m intervals so as to ensure sufficient space for the aquatic life in the stream. These check dams are made hollow in which a biofilter sheet is placed just at a sufficient height from the base. The straight and inclined portion of the check dams are made with the normal concrete and the upper portion which comes in contact with crest is done in pervious concrete. The jet of water flowing over the dams passes directly through the pervious concrete and then filtrates by the filtration media and finally gets settled at the bottom of the dam. Then, this settled water is then converted into air by a complex mechanism in the check dam and a pipe known as sparge well is then provided to circulate the air and thus inject it into the water table. Now this sparge well injects the air into the water table due to which it converts the pollutants associated with petroleum hydrocarbons, crude oil, and many other contaminants from dissolved to vapourised state. And later this vapour is extracted, it is treated and then released off into the atmosphere as a fresh air. Now, this entire process of purifying the water table and thus releasing a fresh air into the atmosphere is known as air sparging technique. For a better plumbing connections and to get the required range of water these check dams are provided in a single alignment with the air sparging stations. Periodic maintenance is to be done for removal of the Biofilter sheet which may result in a tedious process but has to be done frequently so as to inject contaminant free air into the water table.

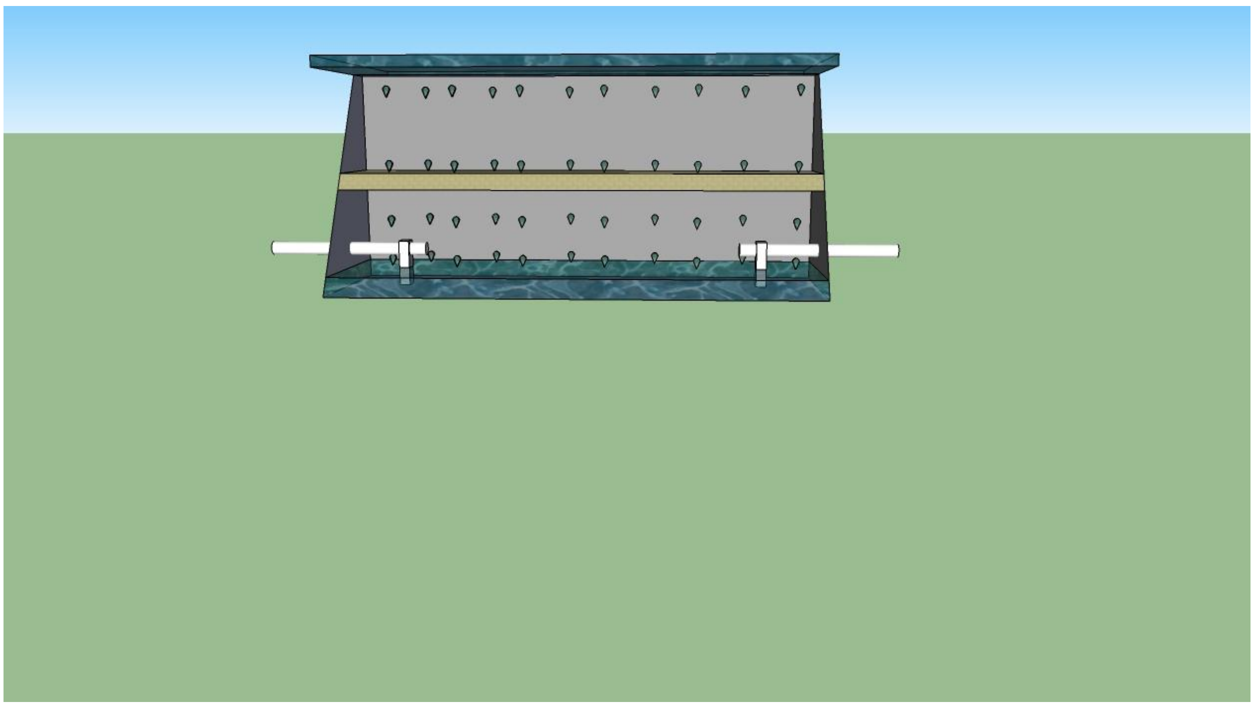

Fig 9. Hollow check dams with Biofilter sheet and plumbing connections

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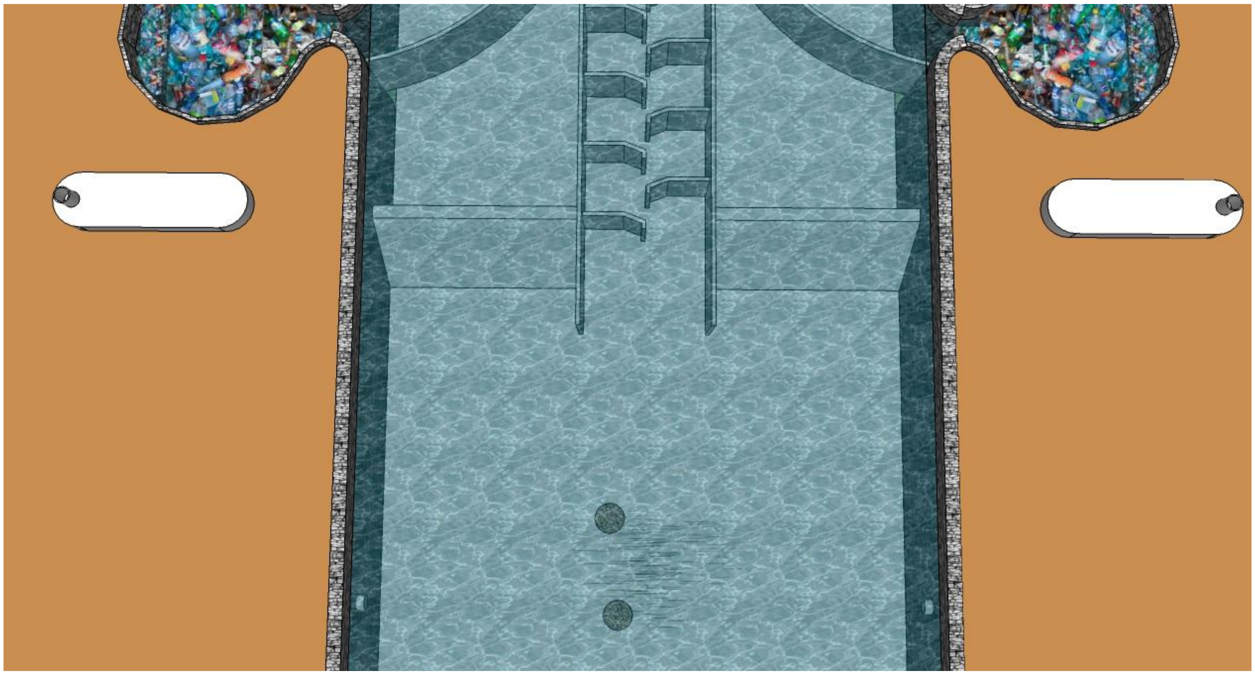

Fig 10. The connection of air sparging stations and the check dam

- *Fish ladder* - will be provided through the check dams for the movement of aquatic animals. These fish ladders are provided with baffle walls. These baffle walls spaced at 1.5m and provided in such a manner so as to prevent it from clogging of any type of waste.

Fig 11. Fish ladder

- *Provision of recreational parks* - Recreational parks are provided on both the sides of jayanti stream so as to make the ecosystem alive and also to utilize the spaces for the purpose of beautification.

This beautification project is been provided with huge number of trees, walking pathways for the people, aerated lagoons are provided which are made just like the ponds.

Fig 12(a) 12(b). Recreational Parks

- *Aerated Lagoons* - are constructed in a circular shape as a simple wastewater treatment system consisting of a pond with artificial aeration to promote the biological oxidation of wastewaters coming from the nearby houses. The depth of the lagoons is kept at 4m and a diameter of 4m is provided.

The inlet zone of the aerated lagoons consists of a depressed floor level and it is reinforced, so that settled sludge and grit can easily be pumped off without risk of damage at normal water level. Now to prevent damages caused by plants or erosion the sides are properly paved with bricks. And the shape of the final clarification or polishing lagoon may vary in a wide range. The depth of the polishing lagoon is kept at 2.50m.

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Aerators are placed in the centre for thorough mixing and oxygen supply in the entire water body at minimal power input. These aerators are preferably mounted on float assemblies. And they are very sturdy and maintenance free. These lagoons are very well intergrated into the surrounding landscapes. They have the following advantages –

- High circulation and mixing capacity.
- Maintenance free
- No risk of clogging, even at intermittent operation or power failure.
- No spray water - no aerosols and odours
- Low noise
- Trouble – free operation during frost

The plumbing arrangement is made in such a way that two chambers are provided under the ground for each house at a depth of 1.53m.(0.30m above the ground and 1.23m below the ground). In one chamber partition is made due to which the black water is collected in one side and the grey water is collected at another side. The grey water is sent forward through pipe into the treatment chamber in which it is treated for household use and then it is circulated upwards for gardening and other purposes. And the black water which is normally the waste water it is then sent directly to the lagoons for treatment. After the treatment the water from the lagoons is sent to the stream and discharged under normal flow conditions.

Fig 13. Lagoons

• *Air sparging stations* - The check dam and the air sparging stations are connected in the same alignment, as the pipe in the check dam converts the filtered water collected at the bottom into air and then it is circulated through the pipe and injected into the contaminated zone of the water table. The pipe injecting the air is called the air sparging well which is mainly taken below the hollow check dam. This process of air sparging mainly involves injecting air into the target contaminated zone, with the expectation that volatile and semivolatile contaminants will undergo mass transfer (volatilization) from the groundwater to the air bubbles. Because of buoyancy, the air bubbles generally move upward toward the vadose zone, where a soil-venting system is usually employed to capture the contaminated air stream.

The pipe carrying the vapourized contaminants is called the soil – vapour extraction pipe involves the use of multiple air injection points and multiple soil vapor extraction points that can be installed in contaminated soils to extract vapor phase contaminants above the water table. Contamination must be at least 3 feet deep beneath the ground surface in order for the system to be effective. A blower is attached to wells, usually through a manifold, below the water table creating pressure. The pressurized air forms small bubbles that travel through the contamination in and above water column. The bubbles of air volatilize contaminants and carry them to the unsaturated soils above. Vacuum points are installed in the unsaturated soils above the saturated zone. The vacuum points extract the vapors through to a Soil Vapor Extraction system.

In order for the vacuum to avoid pulling the air from the surface, the ground has to be covered with a tarp or other method of sealing out surface air. Surface air intrusion into the system reduces efficiency and can reduce the accuracy of system metrics. The tarp is used to stop vapors from breakthrough to the surface above.

The air sparging system treats the off-gases (referred as contaminated vapors and extracted air).

The vapor is treated with granulated activated carbon prior to release to the atmosphere. For example, arsenic-contaminated groundwater were treated by air sparging and what the treatment does is remove arsenic at certain percentage using solution of iron and arsenic only at a molar ratio of 2. Treatment using air sparging is beneficial as groundwater contains high amounts of dissolved iron, which contains the theoretical capacity for the treatment.

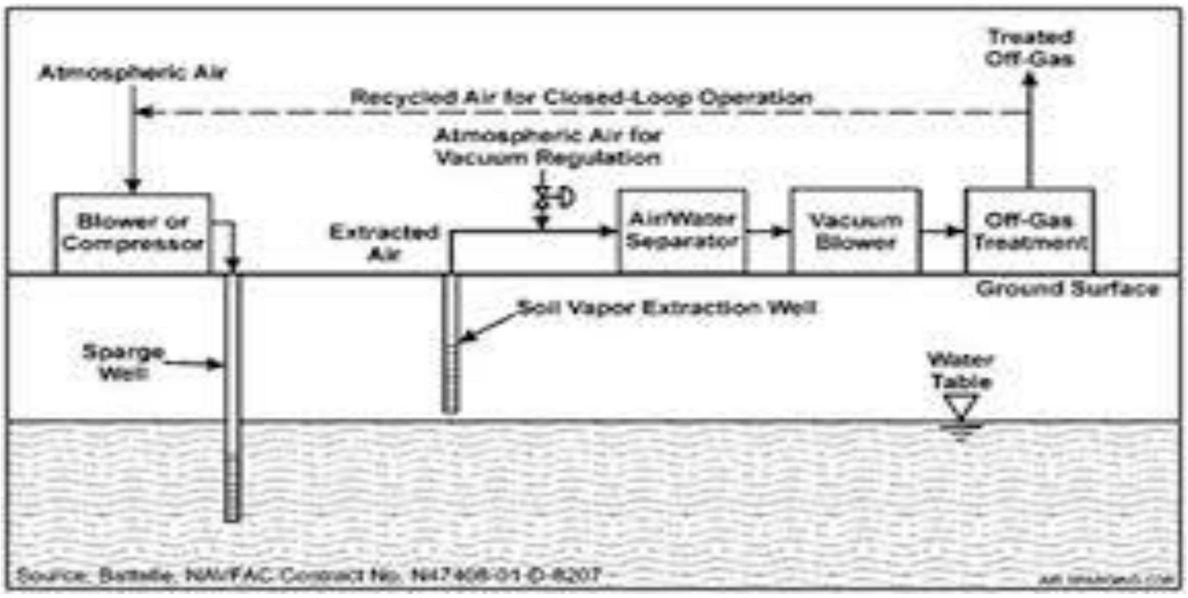

Fig 14. Schematic view of air sparging systems

Fig 15. Step-by-step procedure of the air sparging technique

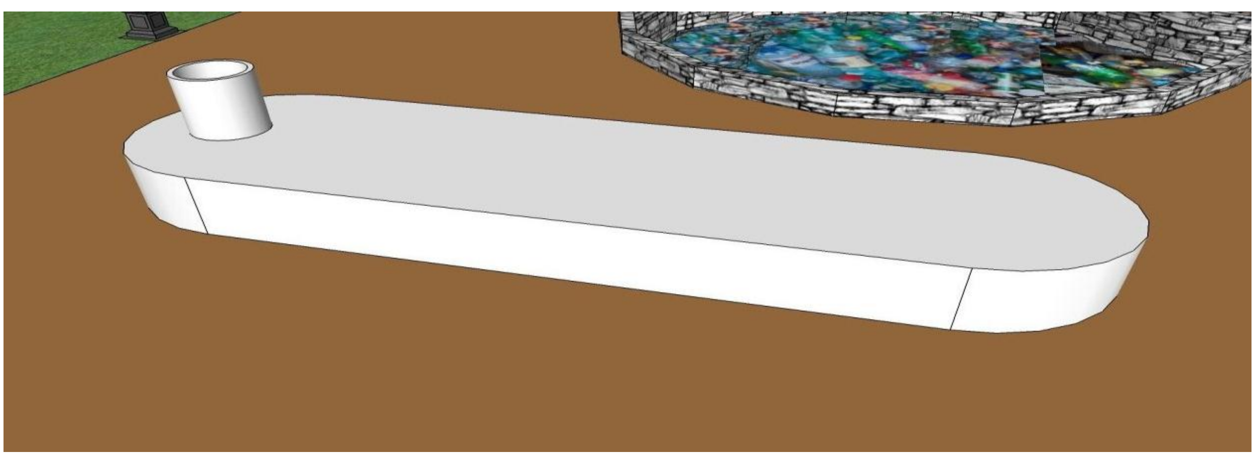

Fig 16. Air sparging stations installed at both sides of the jayanti stream with a pipe vertically taken out to release the treated pure air

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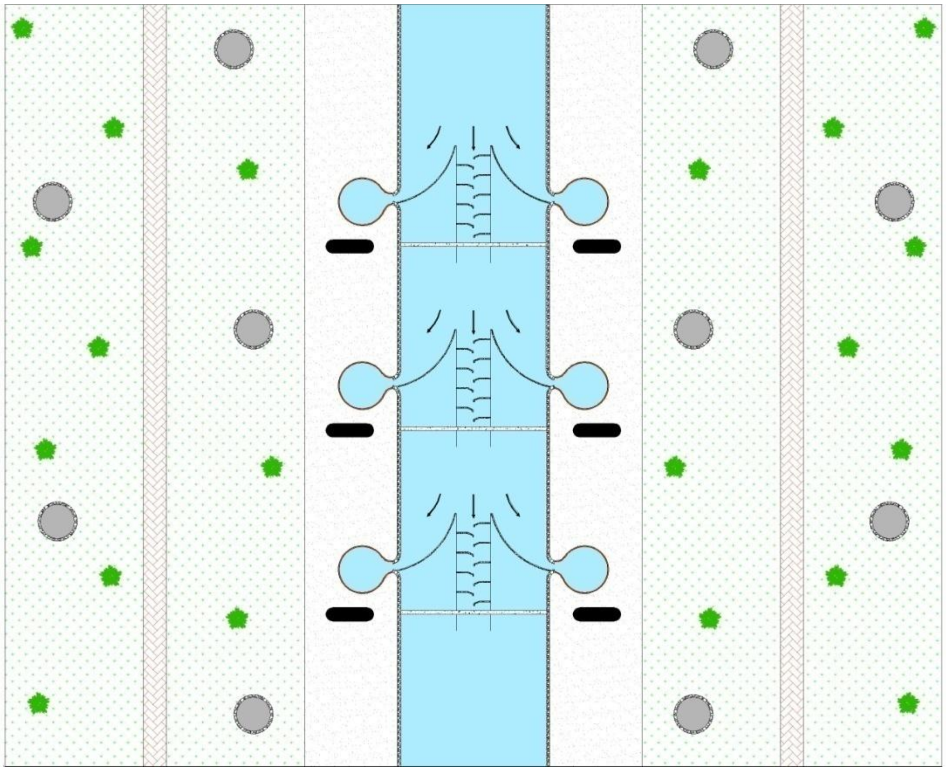

Fig 17. Developed plan of the jayanti stream

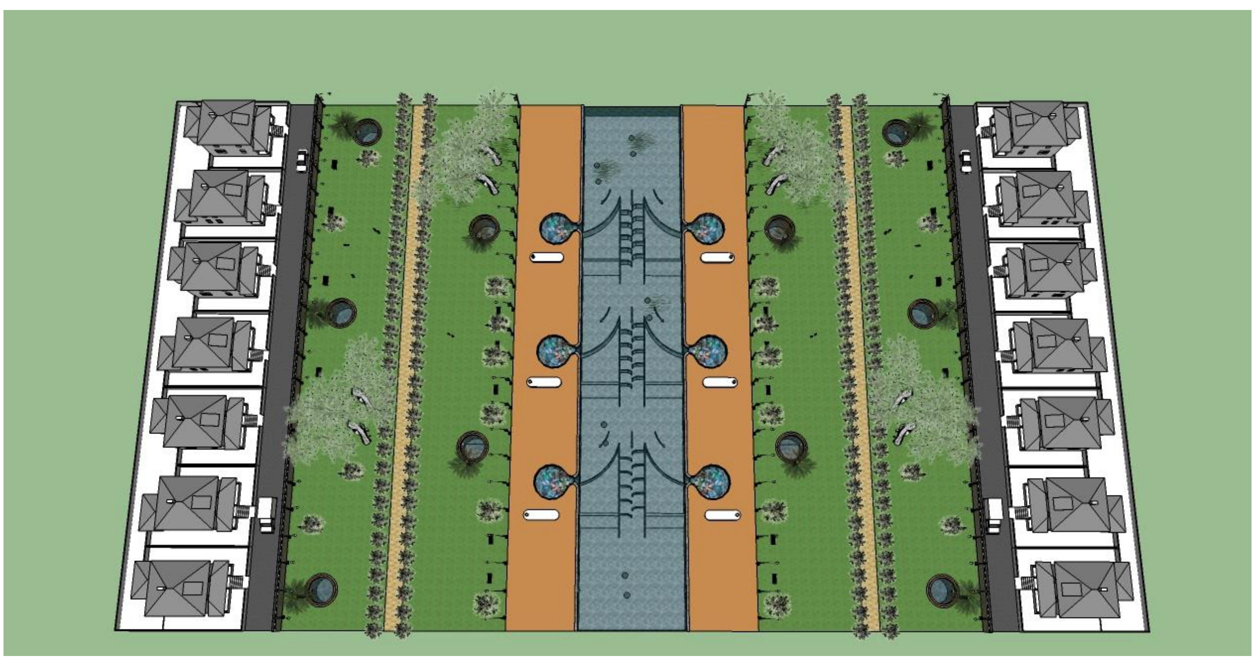

Fig 18 (a) 18 (b) 18 (c). 3D view of the jayanti stream and the surrounding area

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VII. Conclusion

In todays scenario, there are lot many river rejuvenation projects are been taking place in every corner of the world.

But in the process of making a certain river rejuvenate, we are only focusing to the treating of that wastewater which is being directly discharged into those rivers and the main purpose of river rejuvenation is left aside. The main purpose of river rejuvenation is to make the ecosystem alive. So, we have to come up with certain innovative concepts which will not only increase the importance of the river creating it as a state's heritage but will also restore the ecological cycle. This concept is basically suggested for jayanti stream of panchganga river because more than 50% of the polluted water in the panchganga river come from the jayanti stream. In this research paper, all the environmental parameters are studied and according to it the sampling of the waste water is done so as to implement a certain productive concept.

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