SUSTAINABLE SULLAGE TREATMENT SYSTEM FOR TOWNSHIP

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Abstract: Almost all the cities in India are facing the issue of sanitation. Now this is impossible to collect the sullage of the city at one place and then treat it. Therefore implementing decentralized sullage system is a challenge in front of us. The time has come that every new development should be a zero discharge. In this way, all new townships should not be dependent on any municipal system of existing town for the sullage treatment. STPs are constructed in such townships, but the cost of construction and maintenance is very high. Generally septic tanks are provided but the effluent that comes out of the ST is not treated. This untreated effluent is hazardous for the environment and ultimately to the human health. This emphasizes the need of a system that works on sustainable principles. It is possible to design a sullage treatment system where sullage is treated by natural ways, very less electricity is consumed and mainly less efforts are required for maintenance. This study seeks to show how a sustainable sullage treatment system can be implemented in townships. This research also focuses on the challenges in implementation and how a pre-planned system can successfully function for longer period.

Key Words: Zero wastewater townships, Sullage, Sustainable treatment systems, challenges in systems, maintenance

1.

1. INTRODUCTION

Studies show that population of India will be around 150 crore till 2030. Growth in population reflects in growth in needs, growth in demands from environment and increased load on all the systems. One of the main requirements which will be burdened and that is fresh water and sanitation.
If we observe the condition of the rivers in India, almost 70% to 80% rivers are polluted. There are many causes of pollution of a rivers. But the main cause is untreated sullage. Indian cities fail to treat its own sullage which ends up in the rivers. Pollution of waterbodies results in unhealthy living conditions. Odor, mosquitoes, land pollution, devastation of life in the water, bad impact on overall ecology and presence of polluting agents in food chain are the visible effects of this pollution.

This emphasizes the importance and need of the treatment of sullage. Looking on the growth of population, the need of water will be high. At the same time availability of water will be less. In this scenario preserving cleanliness of waterbodies is essential. Simultaneously, load on treating sullage will also high. If proper systems are not implemented today, it will put tremendous load after few years. There are some systems functioning. But the percentage of such systems is very less.

Table 1: status of untreated sewage [1]

Decadal Trend of water supply and sanitation status in Class I Cities and Class II towns

Parameters	Class I cities			Class II Towns		
	1978-79	1989-90	1994-95	1978-79	1989-90	1994-95
Number	142	212	299	190	241	345
Population (millions)	60	102	128	12.8	20.7	23.6
Water Supply (mld)	8,638	15,191	20,607	1533	1622	1936
Wastewater generated (mld)	7,007	12,145	16,662	1226	1280	1650
Wastewater treated (mld)	2,756 (39%)	2,485 (20.5%)	4,037 (24%)	67 (5.44%)	27 (2.12%)	62 (3.73%)
Wastewater untreated (mld)	4,251 (61%	9,660 (79.5%)	12,625 (76%)	1160 (94.56%)	1252 (97.88%)	1588 (96.27%)

Conventional treatment is done in large scale STPs (sullage treatment plant). Here sullage from the city is collected and treated to the level when it is safe to dispose in the rivers or lakes. The construction of STP is very costly. Maintenance of STPs is also very high. These costs are difficult to bear. These STPs depend on electricity for function of various valves and pumps. In that way they are putting extra load on environment. Many STPs are sanctioned but not built due to unavailability of funds, many STPs were built but not maintained because of the cost of maintenance. Ultimately conventional systems fail to treat the sullage up to the desired level and pollution of the rivers is still not stopped.

This proves that collection of the sullage from larger area is difficult to treat. So treatment should be done at smaller scale. Decentralized sullage treatment is the possible solution. If every new township or neighborhood has its own sullage treatment system, it will reduce a burden on municipal corporations. Thus, every new township must have its own sustainable, easy maintenance sullage treatment system which will be a zero wastewater system.

The decisions about selection of wastewater treatment depends upon the quality and quantity of wastewater. So, study of the composition of domestic wastewater is important.

2. COMPOSITION OF DOMESTIC WASTEWATER

Domestic wastewater is all the water from toilets, kitchen, wash basin and laundry. Basically this wastewater is of two types. The water from WCs, Urinals and kitchen is termed as black water. The water disposed of from the bathrooms, wash basins and laundry is called as greywater.

If all this water needs to be treated, its composition should be studied. There are particles which are solid particles and canbe removed by filtering and settling. Human excrete needs a proper process after which we can reuse it in the landscaping.

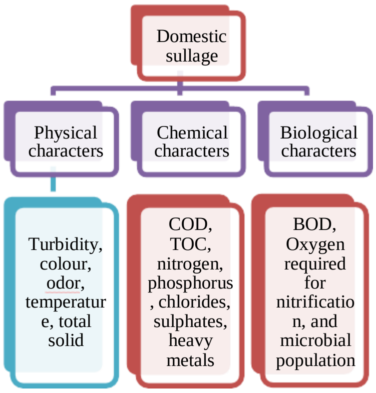

Figure 1: characteristics of domestic wastewater

The above chart shows the physical, chemical and biological characters of the domestic wastewater. There are solid as well as dissolved particles present in the wastewater which can be removed by different methods. Thus a chain of various processes is essential for the treatment.

3. COMPOSITION OF DOMESTICWASTEWATER

3.1 Nitrogen – This is a very important polluting constituent. Nitrogen is present in the domestic sullage in the form of proteinaceous matter like urea (i.e. organic nitrogen). Decomposition of Nitrogen by bacteria results in Ammonia. When ammonia undergoes aerobic process it changes into nitrites and nitrates. Nitrates are used by algae to form plant proteins. Nitrogen is measured as TKN.

3.2 Phosphorus – Sources of Phosphorus in wastewater are human excreta and detergents. Algae consumes phosphorus in the form of phosphate. This cycle of phosphorus is very slow and require more time for removal.

3.3 Pathogens – There are various bacteria (coliform group) and viruses present in the wastewater. If water containing these pathogens is consumed for drinking or irrigation, these pathogens enter the food chain and cause threat to health of humans as well as animals.

3.4 Heavy metals – The most common toxic heavy metals in wastewater include Arsenic, Lead, Mercury, Cadmium, Chromium, Copper, Nickel, Silver and Zinc. If these metals enter the food chain via aquatic animals or plants, they may cause adverse effect on human health.

3.5 Organic matter – It is composed of proteins, carbohydrates and fats. They are measured in BOD (biochemical oxygen demand) and COD (Chemical oxygen demand)

4. Effect of pollutants on environment

4.1 Pollution by organic matter – Breaking down or decomposition of organic materials by microbial and other biological activity is called as biodegradation. This process undergo in the presence of oxygen. That means, dissolved oxygen is used for this decomposition. More organic matters present in the water more dissolved oxygen is utilized. Almost all aquatic species are dependent on the dissolved oxygen. If this DO level is deceased, it affects the aquatic life.

4.2 Effect of nutrients – Nutrients are in the form of nitrates and phosphates. These nutrients are important for plant growth. But when these elements are present in excess amount, it results in overabundance of plant life in water. This effect is called as eutrophication. This can occur at both microscopic level in the form of algae or macroscopic level in the form of larger aquatic weeds like water hyacinth. More hazardous effect of these excess plants is diurnal change in the level of dissolved oxygen. During daytime, Oxygen remains supersaturated due to function of algae in presence of sunlight (photosynthesis). But during night oxygen level depletes as the algal mass consumes oxygen.

4.3 Effect of high dissolved solids (TDS) – Dissolved solids mainly consist of bicarbonates, carbonates, sulphates, chlorides, nitrates and phosphates of calcium, magnesium, sodium, potassium etc. More dissolved solids make the water non drinkable. If this water is used for irrigation, it causes salinization of soil and non-productive land. Such water is undesirable for industries because it may cause scales, foaming in boilers and accelerate corrosion.

4.4 Effect of toxic pollutants on water quality – These are mainly heavy metals, pesticides and industrial pollutants. Pollution happens when natural elimination process cannot function well. Accumulation of metals in Biota occurs through food chains which is hazardous for human health.

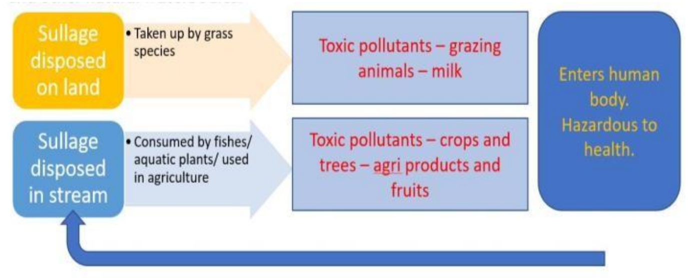

Fig 2: Effects of untreated sullage

5. Water quality monitoring

CPCB in collaboration with SPCB has established a network comprising of 1700 stations in 27 states and 6 union territories spread over the country. The monitoring is done on monthly basis for surface waters and on half yearly basis in case of ground waters. The monitoring results obtained indicate that organic pollution is predominant cause of pollution.

6. Conventional method of sewage treatment:

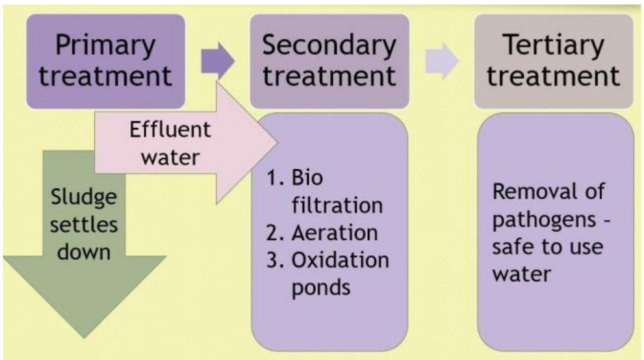

Fig 3: Conventional sewage treatment

Figure shows the conventional method and process of sullage treatment. The primary treatment is done in Septic tanks where anaerobic process separates solid particles, effluent water and gases. This effluent water is further treated in the secondary treatment plants. The secondary treatment is time and land consuming and costly. This is why conventional STPs are costly and require more maintenance. Out of these, wastewater treatment by using plants is found most effective.

7. Natural systems that filter impure water:

Natural wetlands are transitional areas between land and water. Natural wetlands are called as kidneys of the earth for their extreme capacity to hold and filter the water. The special species of the plants in the wetlands are evolved to sustain in impure water and absorb those ingredients from water which general plants cannot absorb. It is proved that this system is effective in wastewater treatments.[10][28][32]

8. What are constructed wetlands

Constructed wetlands for water treatment are complex, integrated systems of water, plants, animals, microorganisms, and the environment. While wetlands are generally reliable, self-adjusting systems, an understanding of how natural wetlands are structured and how they function greatly increases the likelihood of successfully constructing a treatment wetland. This chapter method provides an overview of the major components of wetland ecosystems and of the most important processes that affect water treatment.

9. Components of CWL

CWL are comprising of the following components that affects overall performance of CWL-

9.1 Water – This is an essential element which connects all other functional factors. Any change in quantity and quality of water directly affects other activities. Thus hydrology of CWL plays major role in its functioning.

9.2 Substrates, sediments and litter – Substrates include soil, sand, gravel, rock and organic materials (compost, sediments and litter). This is important part of CWL for several reasons –

- They support many living organisms in WL.
- Permeability of substrate affects movement of water.
- Many chemical and biological (microbial)actions take place within substrate.
- Many contaminants get stored in substrate.
- Help in accumulation of litter which increases quantity of organic matter which is a source for carbon for further reactions.

9.3 Vegetation – Vegetation is of two types algae and large plants. They stabilize and channelize the flow of water. Lowers velocity of water allowing suspended materials to settle. They take up carbon, nutrients and incorporate them into plant tissues. Transfer of gases between atmosphere and water. Stem and root systems provide sites for microbial attachment.

9.4 Microorganisms – Functions of CWL are mainly managed by micro-organisms. They include bacteria, yeasts, fungi, protozoa, ring algae. Microbial biomass is major sink for organic carbon. Microbial reactions transform organic and inorganic matter into soluble form and help in recycling of nutrients. Microbial colonies are combination of aerobic, anaerobic and facultative organisms. This quality help in functioning of CWL in any circumstances. Micro-organisms adjust to changes in water temperature and volume. Important factor is they get easily affected by toxic substances such as pesticides and heavy metals.

10 Case study 1: Nulla park, Pune

Fig 4: Nulla park, Pune

Natural streams in the city are interconnected. These streams were extremely polluted by solid waste dumping, construction debris and untreated sullage disposal. Pune municipal corporation acted wisely on these problems and invented simple strategies to overcome these issues. Before implementation of any system, attention was given on the cleaning and restricting solid waste dumping in streams. For the filtration of the polluted stream following steps were followed-

Step 1 – Triple filtration of water through pebbles, stones and plants. This concept was termed as green bridges.

Step 2 – Plantation – Bamboo was planted on larger area. Bamboo has many advantages. This plant avoids soil erosion,

provides good ground cover, attracts birds, supply more oxygen, easy to grow and roots cleans the water.
Step 3 – Problem of mosquitoes in stagnant water was resolved by keeping Gambusa fish in the water.
This project of stream restoration was presented at the Rio earth summit,1992.

10.2 Case study 2: Decentralized waste water treatment at Auroville [2]

Fig 5,6: Systems in Auroville

Generally, plant treatment systems require larger land area. In Auroville, this was not considered a problem. Larger treatment area was treated as landscape area. Overall, root zone treatment system is used followed by oxidation ponds with aquatic plant treatment.

10.3 Case study 3: Rainbow drive society, Bangalore

Fig 7: System in residential society

This residential complex purifies and reuses all its wastewater. Salient features of this system are –
Capacity of the system to purify the wastewater is 2.5 MLD
Anaerobic process tank size is 8 m x 8 m x 4 m
Reed bed size is 30 m x 10 m x 2.5 m
Various nitrate removing species of plants are used. The system comprises of three zones namely inlet zone with gravels and stones, treatment zone with plants and outlet zone for disposal of treated water. The image shows the treatment zone where water is not exposed and thus avoids problem of odor and mosquitoes.

10.4 Inferences from case studies-

All the above mentioned case studies are chosen from different parts of the country. Their scope, available funds, available area, daily load of the wastewater, composition of the wastewater was different. But one thing is common in all and that is **natural treatment to wastewater without compromising the quality of the environment.** Following are the inferences –

1. Identification and quantification of a problem is an important step.
2. Stepwise planning and implementation makes it easier to solve big issue.
3. Selection of plant species for the treatment needs to be done according to the intensity of the problem.
4. Other problems arises with wetlands or wastewater treatment plants. They are mosquitoes and pests like rats. This has to be thought of before execution.
5. Construction of wetlands is not a simple task. Maintaining the slope and flow of water, sealing retention tanks and wetland channels, provision of pumps if natural slope is not available are issues which should be taken into consideration.
6. Afterall, constructed wetlands are a system and like other systems this also needs periodical maintenance.

11 Quantification of generation of sewage in a typical township-

Assumed population is 5000
By thumb rule, 70 to 75% of consumed water is disposed as grey water and 30 to 35% goes out in the form of black water.
Grey water generated per day would be 5000 x 135 x 0.70 = 4,72,500 lit = 5 lakh lit
Black water generation would be = 5000 x 135 x 0.30 = 2,02,500 lit = 2 lakh lit
If all this 7 lakh lit water undergoes same system, a large septic tank would be required. Thus separation of grey and black water at the source of generation would be convenient. Greywater require less efforts to filter compared to black water. So, there should be two separate systems to treat grey and black water.

12.1 Process to treat greywater [8]–

Step 1: All the greywater should be collected in a retention tank. The retention period is 1 day. In this period all the solid particles in the water settle down. This water is then treated with the help of plants in wet land.
Step 2: Filtration through the bio filters- Greywater in the retention tank is filtered through bio filters that is through sand, gravels and stones. This process removes further fine particles present in the water.
Step 3: Wet land treatment - The wetland requires almost 6 to 7 days to purify the greywater. That simply means one wetland channel or tank should retain the water for 6 to 7 days. In a township, daily generation of greywater would be 5 lakh lit. To treat the greywater effectively, there should be 7 separate wetland channels in the site. The capacity of one wet land channel would be 450 to 500 CuM that comes to around 18 m x 10 m x 2.5 m
Step 4: After wet land treatment, greywater can be used in landscape directly. If this water is reused for flushing in toilets, this needs a one more step filtration which is called as polishing of water. In this process water again filtered through fine sand and then stored in tanks.

Fig 8: Greywater treatment process

12.2 Process to treat black water –

Step 1: Black water should be treated in a septic tank and should undergo anaerobic process in which solid organic matter settle down as sludge. Methane and carbon dioxide are by-product gases which are removed through vents. And major part of the blackwater turned out in the form of effluent water. This effluent water is further treated in CWL.

Step 2: Effluent water also contains some solid impurities which settles down in a retention tank when kept in a tank for 1 day without disturbance.

Step 3: After retention period this water is filtered through bio filters and released in the wet land channel.

Step 4: Wet land treatment cleans the pollutants, chemicals and removes heavy metals. Effluent water needs one more step of filtration before using in gardens and that is oxidation ponds.

Step 5: The oxidation pond is a pond where the water from wet lands is stored and undergoes oxidation. In this process most of the water evaporates. Remaining water can be used in gardens.

For all these processes for grey as well as black water, total land area required is around 1500 sqm. **In a township of 5000 occupants 1500 sqm land area should be dedicatedly reserved as treatment areas.**

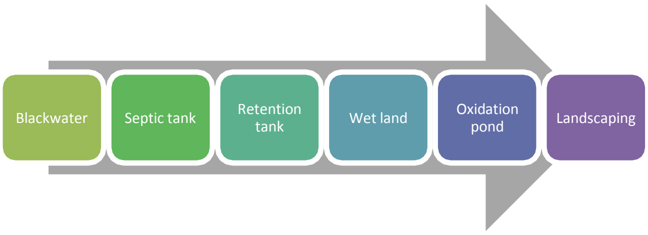

Fig 9: Blackwater treatment process

12. Types of CWL [2][3]

Depending on the level of water and substrate, there are three types of wetlands-

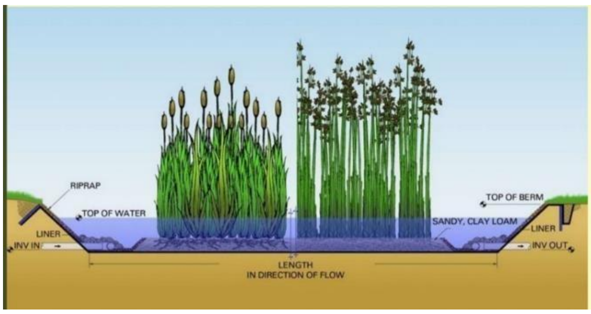

Fig 10: Surface flow CWL

12.1 Surface flow wetlands – This type of CWL consists of a shallow basin, soil or other medium to support the roots of vegetation and a water control structure that maintains a shallow depth of water. The water surface is above the substrate. This type of CWL is mostly suitable for mine drainage and agricultural runoff. The main advantage of this type of WL is their capital and maintenance cost is low. At the same time they require larger land area.

13.2 Subsurface flow wetlands – This CWL consists of a sealed basin with a porous substrate of rock or gravel. The water level is designed to remain below the top of the substrate. This method is called by several names including vegetated submerged bed, root zone method, microbial rock reed filter and plant rock filter system. [24] This system is suitable to treat wastewaters with relatively low solids concentrations. The advantage of this type of WL are greater cold tolerance, minimization of pest and odor problems and less area requirement compared to SFWL. Porous medium provides greater surface area for treatment contact than in SFWL.

These wetlands further classified as horizontal flow and vertical flow constructed wetlands. In the vertical flow constructed wetland, the effluent moves vertically from the planted layer down through the substrate and out. In the horizontal flow CWL the effluent moves horizontally via gravity, parallel to the surface, with no surface water thus avoiding mosquito breeding.

There are few disadvantages also. They are expensive to construct. SSFCWL are more difficult to regulate than SFCWL. Maintenance and repair cost is higher. Furthermore clogging and unintended surface flows are a problem.

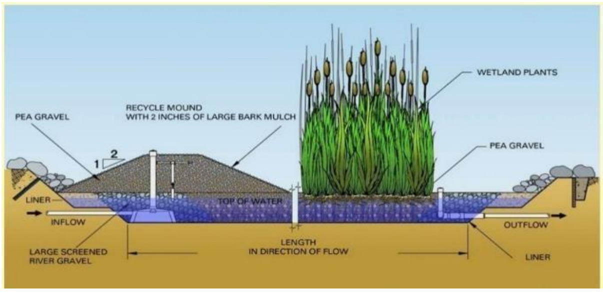

Fig 11: Subsurface flow CWL

13.3 Floating wetlands – floating treatment wetlands or islands are small artificial platforms that allow these aquatic emergent plants to grow in water that is typically too deep for them. Their roots spread through the floating islands and down into the water creating dense columns of roots with lots of surface area. The benefit of these wetlands is the plant roots and floating island material provide extensive surface area for microbes to grow- forming a slimy layer of biofilm. The biofilm is

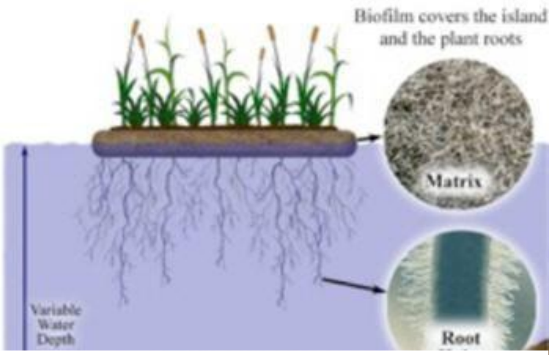

Fig 12: Floating CWL

where the majority of nutrient uptake and degradation occurs in a FTW system.

14 Challenges in design of CWL [13][17]-

CWL and aquatic plant treatment systems should be planned and designed as per the requirements. For the smooth and successful functioning of these systems some points should be thought before. Following are the design considerations –

1. Site conditions [4][5][8][12]–
   a) Topography of the site – Wet land system works on the flow of water. The flow can be maintained naturally if site has a proper slope. Very steep slope and flat land areas needs more intricate design of wetlands to maintain the flow. If this is not possible, pumps needs to be installed. Functioning of pump should be monitored and supply of electricity should be made available.
   b) Water table – Depth of wet lands is not more than 2 m to 2.5 m. If water table of the site is high, wet land channels should be constructed and sealed with proper materials to avoid mixing groundwater in wetland channels.
   c) Soil type – In the process of wetlands, soil - water contact is very important. This depends on soil's capacity to remove and retain contaminants. Sandy or gravely soils have high porosity, thus water moves quickly through the soil. On the other hand, silty or loamy soil holds water resulting in longer soil water contact.
   The soil must provide enough organic matter to fuel plant growth and microbial activity. If the soil on the site of wetland is not fertile, additions of manure or organic matter is necessary at least in the starting period.
   Texture of soil affects growth of root and the retention of pollutants. Coarse textured soils have a low potential for pollutant retention but less effect on root growth. These soils can hold plant well, but nutrient levels are low. Till the period when organic litter builds in the wetland, addition of manure is required.
   Medium textured or loamy soils have high retention of pollutants. They are soft and friable allows rhizome and root penetration.
   Dense soils such as clays and shales should be avoided because they may inhibit root penetration, lack nutrients and have low hydraulic conductivity. Although such soils aid in phosphorus retention but low nutrient content may limit development and growth of plants.

2) Effect of seasons – Extreme weathers affect the growth of plants in wetlands. Wherever constructed wet lands are to be planned, the climate and season patterns needs to be studied. Monsoon period may increase the load on wet lands as there will be excess water in the channels. In Summer period, evapotranspiration rate is higher which increases chances of drying of wet lands. This may increase the concentration of the pollutants in the wet lands which will result in dying of plants. To avoid such problems following considerations needs to be taken into account [9]
   a) Monsoon period loads – While designing the wet lands, separate channels for rain water should be provided. As far as possible, mixing of rainwater in wet lands should be avoided.
   b) If summer period is extreme, provision for excess water should be there. If needed water needs to be added in the wetlands to avoid drying.

3) Everyday peak loads – Though a CWL is designed to cater daily loads of wastewater, in some circumstances load may increase which will lead to the failure of system. Some conditions can be referred as follows –
   a) Small error (blockages, leakages etc) in some part of the system may lead to failure of the system.
   b) Excess wastewater coming in the system

4) Growth of harmful insects or pests –
   a) Stagnant water causes growth of mosquitoes and other disease spreading insects.
   b) If wet land areas are not constructed properly, this will result in existence of pests like rats which causes lot more damage to the property and residents.

5) Selection of plants [4][9][11][12]– CWL are generally planted with emergent vegetation (non woody plants that grow with their roots in substrate or in water and their stems and leaves emerging from the water surface. The selection of plant mainly depends on type of CWL as shown in figure

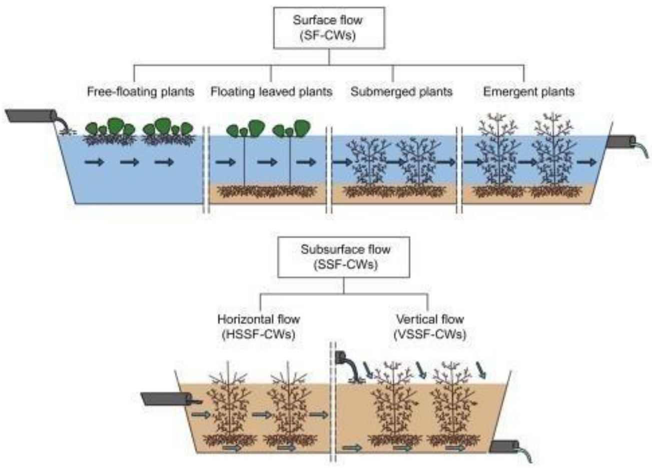

Fig 13: Types of CWL

The following study shows the factors to be considered while selection of plants

Table 2: Criteria for selecting plants

Factors	Comments
Local experts	Take a consult from an experienced person from government agencies and private companies.
Native species	Rate of Survival will be high of native species.
Tolerant of High nutrient load under flooding condition	Select the plant which wills survive in continues flow of waste water.
Growth characteristics	Long lasting plants are generally preferred over annual plants because plants will continue growing in the same area and there is no concern about seeds being washed or carried away. For emergent species, persistent plants are generally preferred over semi-non-persistent plants because the standing plant material provides added shelter and insulation during the winter season.
Rate of growth	Slower growing plants will require a greater number of plants, planted closer together, at start-up to obtain the same density of plant coverage in the initial growing season.
Wildlife benefits	If the wetland is to be used for habitat of wildlife, select the plants that provide food, shelter for particular animal.

In case of plants, one more study is required and that is their growth pattern and lifecycle. The CWL is a pre-planned system. We should study how long a plant take to function maturely. Time of plantation should be early with respect to actual use of that site. For plantation, season plays important role. Plant should be planted in the season which is most comfortable for growth.

6) Detention period – Treatment performance of CWL depends on detention time. A time period of 6 to 7 days has been reported to be optimal for the treatment of primary and secondary wastewater. Shorter detention times do not provide adequate time for pollutant degradation to occur. The problem associated with this

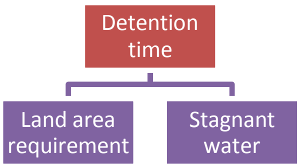

Fig 14: Effects of detention period

factor is longer stagnant water which leads to anaerobic conditions.

7) Odour – This can be considered as a cause for failure of this system at many places. To treat this problem, it is important to understand the sources of odour.

7.1 Methane – When the sewage is digested in the septic tank, methane and carbon dioxide are produced as a biproduct. Methane is lighter gas and easily mixes in the ambient air. The existence of the methane can be experienced by its smell.

7.2 Decomposition – Decomposition in wetlands as well as in oxidation pond generates methane.

7.3 Poor maintenance – If filters, wetland channels or oxidation ponds are not cleaned properly, the organic

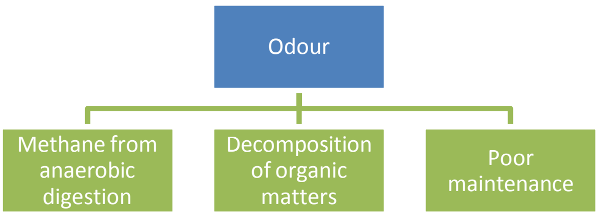

Fig 15: Causes of odor in CWL system

particles gets accumulated and decomposition of these matters may causes the odour.
This is why, the location of the such a system in site is very important. It should be planned as far as possible from residential areas.

15. Other processes involved with CWL

15.1 Primary treatment – To reduce capital and operating costs, minimal pre-treatment of wastewater prior to discharge to a wetland is desirable. The anaerobic treatment in septic tanks is desirable which will remove solid organic matter to a great extent. The effluent water which comes out of the septic tank can be then treated in wetlands.

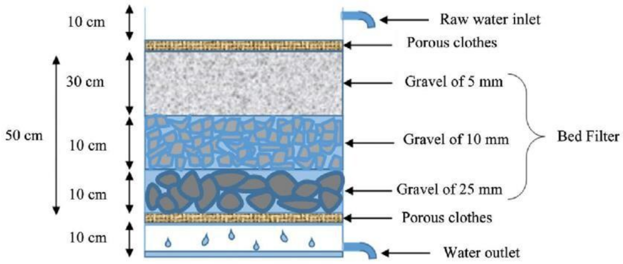

Fig 16: Example of biofilter

15.2 Filters – The effluent water should be filtered through biofilters before releasing it into wetlands. This further removes solid particles present in effluent water. If not filtered, these solid particles will settle down in the substrate and decompose there which will result in sludge formation in wetlands and odour from decomposition of these organic matter. Filters are simple tanks of layers of porous material at top followed by sand, fine gravels, medium gravels, large gravels and finally a porous medium. Inlet for effluent water is kept at top and filtered water is taken out from the bottom.

15.3 Oxidation ponds – Oxidation ponds are shallow pond those are generally used for treatment of wastewater. They are also called as stabilization ponds or lagoons. In these ponds wastewater is treated by combined function of algae and bacteria. Algae grow by using sunlight, carbon dioxide and inorganic compounds released by bacteria in water. During the process of photosynthesis,

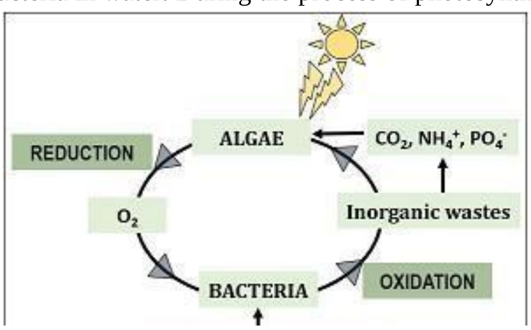

Fig 17: mechanism of oxidation pond

the algae releases oxygen which is further used by aerobic bacteria. The pre-treated water from CWL is finally treated in oxidation ponds where left out organic particles are decomposed and this water can be then used in landscaping. [21]

16. Maintenance and monitoring of CWL

CWL is a system to treat wastewater. Every step involved in the system is important as next step depends on the previous treatment. Clogging, overflowing of wastewater may make site conditions unfavorable. This is why proper periodical maintenance and replacement of parts (if needed) is prior concern in the CWL systems.

16.1 Maintenance of STs – The important factor associated with septic tanks is the generation of sludge at the bottom. Desludging of septic tank should be done periodically. All the inlets and outlets should be cleaned once in a year.

16.2 Maintenance of filters – The filters discussed in this paper is a eco filters. The function of filters is stopping any solid (leaves, organic matter, paper, plastic etc) waste entering into CWL. Solid matters like plastic or paper may block the path of water in filter. This may cause clogging of water. Organic waste particles which gets captured in filter. The process of decomposition of organic particles in filters continues and may produce foul odour. So, cleaning of filters is a priority work in overall maintenance.

16.3 Maintenance of CWL – The wetland channels are main operating part of the system. For the easy maintenance, CWL can be divided into three parts -

16.3.1 Maintenance of substrate – Substrate is medium necessary for the growth of roots. Decomposed matter settles down in the form of sludge in substrate. So cleaning and removing sludge is essential.

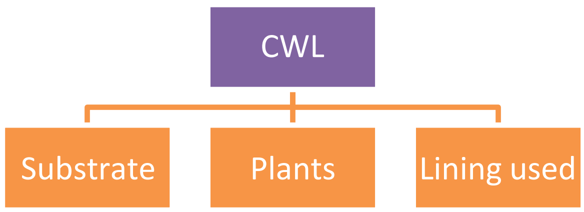

Fig 18: Parts of CWL for maintenance

16.3.2 Maintenance of plants –Every plant has its own lifecycle. After a period a plant's absorbing capacity may decrease. Some plants absorb heavy metals and these gets stored in the parts of plants. Thus cutting, removing and replanting of plants is required.

16.3.3 Maintenance of lining – Generally plastic lining is used for construction of CWL. If this lining gets damaged, it may cause percolation of wastewater in the ground and creates a passage for ground water into CWL. This is hazardous for CWL as well as site. Periodical checking for lining should be done. Repairing or replacing of materials should be done as per the requirement.

16.4 Maintenance of oxidation ponds – These shallow ponds allow oxidation of organic matter in the water. This is done by the combined function of algae and bacteria. Overgrowth of algae will disturb the balance in reactions. Algae can function in sunlight. That means cleaner surface of water is required for the smooth functioning of algae. Hence, overgrowth of algae and plant growth on the surface of water should be monitored and controlled.

Conclusion

The above discussion on the use of CWL for sullage treatment in townships clearly gives an idea that CWL is a very effective system for treatment of wastewater. This is a complex system and only feasible when pre planned. Pre planning on every step is key towards success of this system. We just have to shape the capability of nature to function for our need. CWL are natural systems modified for our purpose. But ultimately these are nature based systems. Wet lands are called as kidneys of the earth for their tremendous capacity to filter the water. These wetlands in the form of constructed wetlands give us the assurance 'we together are not powerless against climate change.

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References

1) Guidelines for water quality management : Published by CPCB, India
2) Natural Decentralised Waste Water Treatment Systems, Auroville centre for scientific research
3) A handbook of constructed wetlands – a guide to creating wetlands for agricultural wastewater, domestic wastewater, coal mine drainage, stormwater. (published by USDA – natural resources conservation service and the US environmental protection agency
4) Design manual : constructed wetland and aquatic plant systems for municipal wastewater (HYDRIK wetland consultants, US environmental protection agency – EPA/625/1-88/022, sept 1998)
5) Role of plants in constructed wetlands: a review (Kruti B Jethwa, Samir Bajpai, Dept of civil engg, NIT Raipur – ISSN: 0974 – 2115)
6) Sewage pollution : Published by CPCB
7) Utah (Yeu Zhang, Utah state university Design of constructed wetland for wastewater treatment and reuse in Mount Pleasant.
8) Constructed wetlands for pollution control : process, performance, design and operation by IWA specialist group on use of macrophytes in water pollution control
9) Small scale constructed wetlands for greywater and total domestic wastewater treatment – Ecosan training course on Capacity building for ecological sanitation – Compiled by Ecosan services foundation and seecon gmbh in the context of the Innovative Ecological sanitation network, India
10) Constructed wetland for a peri-urban housing area, Bayawan city, Phillipines
11) Constructed wetlands for wastewater treatment and wildlife habitat : US environment protection agency (EPA832-R-93-005, Sept 1993)
12) R Kaur, SP Wani, AK Singh, K Lal Wastewater production, treatment and use in India,; *Water* Technology Centre, Indian Agricultural Research Institute, New Delhi, India *2* International Crops Research Institute for the Semi-Arid Tropics, Hyderabad *3* Indian Council of Agricultural Research, New Delhi, India
13) https://www.slideshare.net/Adithya706/oxidation-ponds
14) http://mohua.gov.in/upload/uploadfiles/files/Water_Mgmt_CPCB_PPT_0.pdf
15) https://slideplayer.com/slide/10180524/
16) https://www.iisd.org/story/floating-treatment-wetlands/#:~:text=Floating%20treatment%20wetlands%20(FTWs)%20or,with%20lots%20of%20surface%20area.
17) https://www.intechopen.com/online-first/constructed-wetlands-in-wastewater-treatment-and-challenges-of-emerging-resistant-genes-filtration-a
18) https://www.drishtiias.com/daily-updates/daily-news-analysis/wetlands-conservation
19) https://www.pulsus.com/scholarly-articles/potential-uses-of-aquatic-plants-for-wastewater-treatment-4608.html
20) https://pubmed.ncbi.nlm.nih.gov/15092171/
21) https://www.cseindia.org/decentralised-sustainable-wastewater-treatment-technologies-3798
22) https://sites.google.com/a/alamsantidesign.com/alamsantidesign---copy/permaculture-developments/wastewater-management
23) https://www.ecoideaz.com/innovative-green-ideas/nullah-parks-of-pune
24) https://www.epa.gov/wetlands/constructed-wetlands
25) https://sswm.info/factsheet/septic-tank
26) http://bengaluru.urbanwaters.in/wastewater-53/
27) http://www.cpeo.org/techtree/ttdescript/phytrem.htm#:~:text=Phytoremediation%20is%20a%20bioremediation%20process,Rhizosphere%20biodegradation.
28) https://www.arviatechnology.com/what-are-the-three-stages-of-wastewater-treatment/
29) http://www.ayala-aqua.com/
30) https://www.cseindia.org/decentralised-sustainable-wastewater-treatment-technologies--3798
31) https://mygate.com/blog/housing-society-sewage-treatment-plants/
32) https://www.wte-ltd.co.uk/reed_bed_sewage_treatment.html

Abbreviations used:

STP – sewage treatment plant
ST – Septic tank
CWL – Constructed wetland
SFCWL – Surface flow constructed wetland
SSFCWL Sub-surface flow constructed wetland
CPCB – Central pollution control board
SPCB – State pollution control board