TENABLE STORM WATER MANAGEMENT

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ABSTRACT

Storm water is precipitation that falls as rain, snow, sleet or hail". Storm water is water that originates during precipitation of about 10% precipitation runs over the land surface and about 50%infiltrates the soil to replenish groundwater flow and base flow to streams. Plants uptake and evapo-transpiration account for about 40 percent. India, as it depends on Monsoon for its rainfall, has a highly seasonal pattern of precipitation, with 50% of precipitation falling in just 15 days and over 90% of river flows in just four months. India occupies approximately 2.4% of the total geographical area of the world, 15% of the world population. [1] Unprecedented population pressure and demand of society on scarce land, water resources and the increasing degradation of these resources is affecting the stability and resilience of our ecosystems. It is precisely to restore this ecological imbalance by developing Smart-Kolhapur. City which is upcoming urban-metropolitan has doubled over the last thirty years (and is now about 30%); agriculture now accounts for only about 25% of GDP economy has been growing at around 7% a year with industrial efficiency approximately producing exports with a value of 25 billion rupee per year with an Annual municipal budget of 1.8 billion.[6] In-spite of these economical development achievements, the current cities are facing problems of resource scarcity due to uncertain climatic, Planning conditions. massive land use such as the number of roads, pathways are being paved which is affecting groundwater recharging these pathways, roads and roofs all are impervious surfaces that do not allow the water to percolate in to the ground and also lead to huge quantity of storm water to flow and go as waste. If this water is saved and treated it can cater to half the demand of the city. The study of project reveals that the Storm water, instead of wasting can be utilized for various purposes like gardening, fire fighting, street washing, irrigation. If this water is directed to the ground it can increase the water table and give plenty of water in the summer season. Even it can be used for irrigation purpose near the city. We propose also to define the concept of Storm-Water-Power some of the distinctive features that it should display to support its sustainability.

Keywords- Storm water, stability, recharging, utilized, Smart-Kolhapur.

I. INTRODUCTION

"Storm water is precipitation that falls as rain, snow, sleet or hail". Storm water is water that originates during precipitation. Storm water does not soak into ground becomes surface runoff, which either flows directly into surface waterways or is channelled into storm sewers, which eventually to surface waters. Plant uptake and evapo-transpiration account for about 40 percent.Storm water flows from higher points on the land to lower points, and is best understood from a "Watershed" perspective. A watershed is a natural region defined by the land area from which precipitation drains into a particular body of water – a river or lake. One watershed may be part of a larger one, or contain several smaller sub-watersheds. Precipitation falls on the land, and then drains from the higher areas over and through the soil until it eventually reaches rivers, streams, lakes, or the ocean. [1]The paved pathways, roads and roofs all are impervious surfaces that do not allow the water to percolate in to the ground and also lead to huge quantity of storm water to flow and go as waste. If this water is saved and treated it can cater to half the demand of the city. If this water is directed to the ground it can increase the water table and give plenty of water in the summer season. If the Storm water is given proper treatment it can be utilized to meet the demands of the city during summer days. Following are some ways which suggest proper utilization of Storm water i.e. regarding scope of sustainable management of Storm water. To build sustainable street projects around the City to better manage storm water runoff and enhance neighbourhoods. Green Streets include storm water curb extensions landscaped with plants that filter pollutants from Storm water runoff, swales that infiltrate and store Storm water runoff, lowered planter boxes, permeable pavement and street.

II. RESEARCH PROBLEM

Kolhapur city has a network of roadside gutters, natural streams and sewers to carry Storm water. The drainage system of Kolhapur constitutes river, natural mullahs and road side drains. The major natural drains are Jayanti nallah, Gomati nallah, Dudhali nallah, Line Bazaar nallah and Bapat Camp nallah. Watershed of these nallahs is greater and during monsoon there is large flow through them which cause flooding in lower part of the city. The main river is Panchaganga flowing from west to east along the northern boundary of the city. All these natural nallahs carry storm runoff along with sewage and discharge in to river Panchaganga causing severe pollution problem of the river water. Most of the roadside drains are not of adequate size and do not have proper inlet arrangements to catch the storm runoff and carry it to the disposal point. Coverage of required size drains is also not sufficient. The existing Cross Drainage works are not properly sized at many locations. Due to irregular cleaning of gutters and nallahs waste is settled and sizes of nallahs are reduced. Roads are also damaging which cause inconvenience to traffic. All these factors leads to unhygienic conditions and various diseases like Dengue, Malaria, Chicken guinea etc.Storm water gets contaminated because of suspended solids, sediment from construction sites, roads, winter sanding nutrients (nitrogen and phosphorous), fertilizers, pet wastes, yard wastes metals, car-oil and grease, pesticides and herbicides etc.

Lack of maintenance and dumping of garbage has also reduced carrying capacity of these natural drains, roadside open drains and culverts causing flooding problems in rainy season.

III. SCOPE

The Kolhapur city is urbanizing rapidly. The development plan indicates a total of 67% area to be developed under Residential, Commercial, Public/semi public areas, recreation, transport etc. This will increase the paved areas substantially resulting in increased runoff.The average annual rainfall in Kolhapur is 1125 mm. (Source: The Indian Meteorological Department, 2009). Rainfall generally occurs between June and September, and there are about 73 rainy days in a year. Kolhapur is located near Sahyadri hill range on the West side and has good slopes and number of natural drainage channels drain the storm runoff along with the sewage generated in the Rapid urbanization has, however put the natural drains under pressure and a number of small natural drains either have disappeared or have been encroached upon.The CD works have not been properly sized. These form the bottlenecks in the city and are causes of localized flooding in many locations. Most of the city roads do not have roadside drains or have inadequate size drain. Increasing paved areas and development is causing water to flow on the roads, causing damage to road surface and putting additional load on the existing road side drains along main roads. Lack of maintenance of drains disposal of solid waste in the drains adds to the problem of localized flooding.

Recent years have seen increased frequency of localized flooding in the city. The Kolhapur Municipal Corporation invests large amounts in road repairs caused by damage to road surface after rainy season. There are many areas in the city that face flooding.This causes widespread disruption of traffic, loss of fuel due to waiting and slow movement of traffic, damage of vehicles, loss of man-hours and damage of roads.The inundation of low-lying areas causes damage to huts and houses. Even though loss of life has been rare, the damage and loss of property has been substantial.

Objectives:-

1. To collect the necessary data for preparation of toposheets and topographic survey.

2. To demark the drainage basins within the city according to topographic survey and develop basin wise drainage network.

3. To suggest design well defined system of efficient transfer of Storm water to its ultimate disposal point with management.

4. To design efficient and economic system to lift the Storm water to appropriate place such as Hydraulic Ram.

5. To analyze the quality and quantity of Storm water from drainage basin and suggest necessary treatment for its utilization.

6. To suggest the alternate use, storage of collected and treated Storm water using effective and advance techniques.

8. To maintain the cleanliness, natural heritage and pollution free environment in the city.

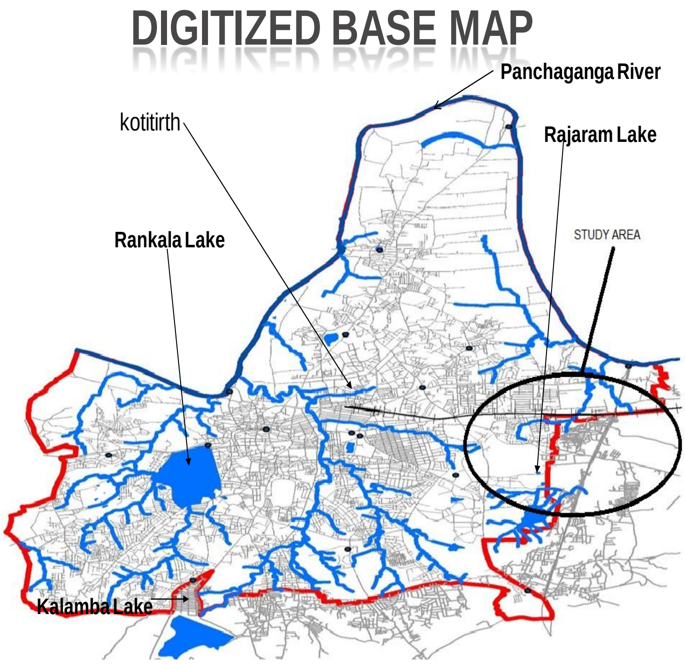

Fig.DIGITIZED BASE MAP FOR KOLHAPUR CITY

IV. METHODOLOGY AND ANYLYSIS

The methodology of the work includes.

1. To conduct topographic survey and prepare plans for storm Water system.
2. To prepare base map using top sheets and topographic survey.
3. To collect rainfall data and carry out statistical analysis.
4. To develop intensity duration frequency curve for two return periods through Rainfall analysis.
5. To carry out detailed analysis of entire basin regarding quantity of Storm water. Review existing Strom Water Drainage disposal works for basin no. C on the basis of its conformity with site conditions to facilitate construction of new drains and usage of existing drains.
6. To define nodes within the network and carrying out adequacy analysis to determine carrying capacity of drainage network.
7. To suggest advanced and appropriate techniques for sustainable development viz. siphon, hydraulic ram.
8. Laboratory testing of samples from drainage basins to ascertain quality of Storm water.
9. To design Low Cost Treatment plant for treatment of Storm water.
10. To suggest suitable system and area for storage of treated Storm water.
11.

a) Return period: The return period is the period in which the chosen storm event will be equated or exceeded. The higher return period therefore indicates less frequent storm events but with higher intensity. The choice of return period depends upon the importance of the project area. The manual of “Sewerage and Sewage Treatment” by CENTRAL PUBLIC HEALTH ENGINEERING AND ENVIORMENTAL ORGANIZATION (CPHEEO) of Government recommends the following frequencies

1. Residential areas

1) Peripheral areas – Twice a year
2) Central and comparatively high priced areas – once a year.

2. Commercial And high priced areas – once in two year

The Kolhapur city is getting urbanized at a very fast pace with mixed nature of development (commercial and residential).Therefore considering the importance of area the return period of two years is adopted.

b) Method of flood estimation-The rational method uses rainfall runoff correlation procedure of estimation of flood. This method is widely used for urban runoff computations, and is also recommended by CENTRAL PUBLIC HEALTH ENGINEERING AND ENVIORNMENTAL ORGNISATION (CPHEEO) of Government. Therefore rational method is used in this study. The mathematical expression of rational method is given by –

$$Q = 10CIA$$

Where, Q = Runoff in cum/hr

C = Coefficient of runoff

I = Intensity of runoff in mm/hr

A = Area in hectare

Intensity Duration Table and Curves:

IDF curves shown in Figure below:

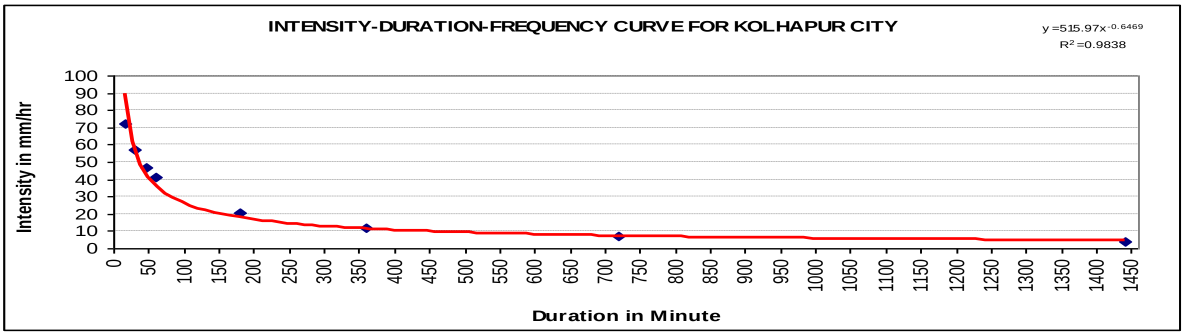

Fig. Intensity-Duration Frequency Curve

Fig. No. (IDF curves: Indian Metrological Department, New Delhi)

d) Time of Concentration-It is the time required for the rainwater to flow over the ground surface from the extreme point of the drainage basin and reach the point under consideration. Time of concentration (tc) for a given storm water drains in calculated by considering inlet time and time of travel.

e) Coefficient of Runoff-The catchment area is classified depending on the proposed land use of the area. The Runoff coefficients for each category of area are assigned values as recommended by (CPHEEO) of Govt. manual, and is summarized below:

Runoff coefficients for Kolhapur city taken as 0.80

Runoff coefficient for different land use area

Runoff Coefficient

Sr. No.	Types of area	Run Off coefficient
1	Industrial / commercial area	0.80
2	Residential – high density	0.70
3	Residential – low density	0.50
4	Open grounds, gardens, lawns etc	0.15

(Source: CPHEEO manual)

f) Area: The area is the drainage land surface contributing runoff up to the point under consideration measured in hectares.

Hydraulic Criteria

a) Natural drains and side drains -The parameter described in this section has been used for hydraulic designs of both the natural drains as well as roadside drains.

b) Hydraulic equation-The hydraulic capacity of the drains is computed by using Manning's formula having the following equation V =

$(1/n)\ R^{2/3}S^{1/2}$ Where, V = Velocity in m/s.

R = Hydraulic radius in m,

S = Invert slope,

N = Manning's coefficient of Roughness.

c) Coefficient of Roughness-The different types of drains exist in the present drainage system. The analysis of drains has been conducted by applying appropriate coefficients of roughness for the drain.The classification of drains used in the analysis and the corresponding values of the coefficient of roughness 'n' used for various types of drains are given in next page.

V. TABLE CLASSIFICATION OF DRAINS

Sr. No.	Description	Manning's "n"
1	Natural drain, meandering with vegetation	0.0350
2	Natural drain fairly straight without vegetation	0.0300
3	BB/Masonry drain walls-Unplastered and natural bed	0.0230
4	BB/Masonry drain walls-Rubble Paving bed (Up to Invert depth 2m)	0.0180
5	BB/Masonry drain walls-concrete bed or Concrete Wall with rubble paving bed (Invert depth more than 2m)	0.0160
6	PCC/RCC drain walls and concrete bed with smooth finish	0.0150
7	RCC pipe sewer	0.0110
8	Concrete wall with natural bed	0.0210

(Source: CPHEEO manual)

d) Velocity-The maximum velocity in the drains shall generally be as 0.60 m/s.

e) Free Board-In case of constructed (Generally rectangular) drains (small to medium size) minimum free board of 10cms is provided.For large size drains (Natural drains converted into constructed drains) a higher free board of 20 to 30 cm is provided.

f) Road side drains-The roadside drains are designed to carry the surface runoff resulting from the cumulative area of the sub-catchments of the section under consideration. The design section is defined by 2 successive Nodes. Hydraulic design of roadside drains is done using Manning's Formula.

Types of drains proposed:

i) R.C.C Pipes Drains:R.C.C. NP-2 class pipes are proposed to be used for such drains with minimum size 450 mm and maximum size 900 mm and minimum cover above top of pipe up to ground level as 0.9 m.

ii) R.C.C. Rectangular section Drains: Cross drainage Works: The existing cross drainage works are analyzed for its capacity. The design runoff without creating overland flooding condition is that afflux generated at the cross drainage work shall be limited to 0.50 m. The afflux calculations are made using the Moles-worth formula, recommended by the Guidelines on design by Public Work Department Government of Maharashtra. The Mathematical expression of the formula is –

Afflux = (V2/17.88 + 0.0153) (A/a) 2-1 Where,

V = Velocity in the approach section – m/sec

A = Cross sectional area of approach section – Esq.

a = Cross sectional area of the culvert opening – Esq.

Table Minimum Vertical Clearance for Particular Discharge

Discharge in cum /s	Minimum Vertical Clearance in MM
Up to 0.3	150
0.3 to 3	450
Above 3 and up to 30	600
Above 30 and up to 300	900
Above 300 and up to 3000	1200

Above 3000	1500

(Source: CPHEEO manual)

Estimation of Deign Runoff-The design storm intensity and consequent sewage runoff are the functions of time concentration. The time of concentration, for each section is worked out, and appropriate intensity is applied, using intensity – duration relation as discussed. The design is worked by using rational formula.

Adequacy analysis-The existing drains are surveyed, with respect to –

- Type of drain, i.e. natural or constructed.
- Sizes.
- Level

Survey-Field survey has been conducted to understand the existing drainage pattern, characteristics of the drainage area such as land use, topography and to record the exact details of drains such as condition The surveys are classified into two categories i.e. Reconnaissance survey and topographic survey and discussed as under.

Lifting of Storm water to appropriate place-The Storm water which is accumulated can be lifted to appropriate place where it is treated for reuse. This treated Storm water is then stored in depressions nearby the city. The Storm water can be lifted to treatment ponds by using a technique i.e. Hydraulic Ram. The Storm water is supplied by gravity to Hydraulic ram which is having inlet opening in one direction only so that water cannot be return to mullah again. There is outlet which opens in outside of tank where an air tight container is fitted. When water enters this container it is compressed during which outlet valve is closed and there is no other way to escape. The water thus enters the lifting pipe and gets lifted.

There are sufficient size depressions where Storm water can be stored nearby the city.

1. Behind Kalama Lake (5 km away from basin C)
2. Padali village on South side of city(6.5 km away from basin C)
3. Near Kasba Bavada (4km away from basin C)

Characteristics of Storm water at Kolhapur City

The Storm water samples at specific points in corresponding area are collected and their characteristics are determined. The main characteristics such as dissolved oxygen, BOD, COD, Total solids are tested in laboratory. In order to provide suitable treatment to Storm water collected, the above characteristics are very important because depending upon the proper treatment can be given.

Table Sampling at place 1- New Palace

Characteristics	Sample 1 (10:00 am) mg/lit	Sample 2 (4:00 pm) mg/lit	Sample 3 (11:00 pm) mg/lit
Dissolved Oxygen	5	6	5
BOD	90	110	170
COD	200	200	250
Total Solids	490	530	600

Table Sampling at place 2- Shahupuri (Kumbhar Galli)

Characteristics	Sample 1 (10:00 am) mg/lit	Sample 2 (4:00 pm) mg/lit	Sample 3 (11:00 pm) mg/lit
Dissolved Oxygen	7	6	6
BOD	98	120	180
COD	200	220	250
Total Solids	520	550	700

Table Sampling at place 3- Jayanti Nallah

Characteristics	Sample 1 (10:00 am) mg/lit	Sample 1 (4:00 pm) mg/lit	Sample 1 (11:00 pm) mg/lit
Dissolved Oxygen	5.5	5	5
BOD	100	110	175
COD	210	230	265
Total Solids	600	690	750

Treatment of Storm water -This Storm water cannot be stored more than 2-3 days because due to retained Storm water there is possibility of production of mosquitoes, insets, flies which may spread diseases like dengue, malaria, cholera etc. and also unhygienic conditions may occur. Therefore a simple treatment can be given to Storm water due to which it can be stored in open large open depressions nearby the city. For storage of treated Storm water following methods can be used.

1. Storage in large depressions nearby the city.
2. Storage at basements of the buildings like large commercial complexes, apartments.

The treatment includes the following steps

1. Screening
2. Anaerobic treatment
3. Aerobic treatment which include a) Facultative pond
   b) Maturation pond
4. Disinfection

Screening-In this process all the floating matter and derbies are removed. Screens help to remove large floating matter.

Waste Stabilization Ponds-These are constructed in earthwork with relatively very small depths as compared to their large surface areas and bunds are built all around to some height. Storm water is directly applied to ponds after removing floating materials through bar racks without any primary treatment. The system has low construction and negligible operating cost as it requires minimum operation skill and does not use any mechanical equipment to supply oxygen. Ponds are multi-celled and can be provided in series or parallel.-

Removal Mechanism-The raw Storm water is fed to basin after screening, the suspended solids settle to the pond bottom by gravity due to long retention period. The soluble organic matter in upper top and intermediate layers are oxidized under aerobic and facultative conditions to carbon dioxide, nitrates, orthophosphate and water by the microorganisms present in raw water. The required oxygen is supplied by photosynthetic metabolism of algae present in the pond. The solids settled at the bottom of tank of pond are decomposed by to stable end products by anaerobic bacteria.

 ISBN: 978-81-932074-5-1

Anaerobic treatment-These ponds are 2.5m to 5m deep in which anaerobic conditions prevail throughout the pond depth except for a surface zone of few centimeters. In this process the Storm water is retained for 24 hrs. Here the BOD of Storm water can be reduced from 135 to 70. Also settlable matter is removed by 85% .The anaerobic pond is to be designed deep enough to create anaerobic conditions. The depth of pond is 4.5m. It is trapezoidal having square top of side 5m and square bottom of side 2.25m. It is provided with outlet at top.

Aerobic treatment-

1. Facultative Pond-The ponds are generally 1.2-2.5m deep and three zones exits throughout the pond depth as a) Aerobic zone at surface, b) Anaerobic zone at bottom and c) Facultative zone at mid depth of the pond. Stabilization of organic matter is achieved by aerobic bacteria at surface, by anaerobic bacteria at bottom of pond and by facultative bacteria in middle zone In this process the Storm water from anaerobic pond is supplied to Facultative pond through outlet at the top of anaerobic pond. The detention period is 4 days. The pond is shallow enough to create aerobic conditions having a depth of 2.4m. It is also trapezoidal having large surface area at top. The top is square of side 50m and bottom is square of side 43m. Here BOD Storm water can be reduced to about 60. Also settable matter can be reduced by 70% as the detention period is sufficiently large. Also DO of Storm water increases due oxidation over large area.

2.Maturation Pond-These ponds are generally 1.0-1.5m deep and normally used after facultative pond with the prime objective of destructing the focal matter or pathogenic organisms. After the facultative pond the Storm water is supplied to Maturation pond where detention period is 2 days. This pond is shallower than facultative pond having a depth of 1.5m. It is also trapezoidal having square top of side 32m and square bottom of side 25m. Side slopes are 1.5:1(H: V). Here BOD is removed up to 30. COD is reduced to 60. DO is raised to sufficient level about 6. Also settable solids are removed up to 20%.

VI. DESIGN CONSIDRATION

Aerobic pond must be designed to have the oxygen supply more than required for oxidation to maintain aerobic conditions in the system. It is essential that proper balance between production of algae and bacteria is maintained in all types of ponds. A first order BOD removal rate is normally assumed in design of aerobic and facultative ponds and the value of rate constant, K, is reported to vary from 0.05 to 1.0 per day depending operational and hydraulic characteristics of the pond.The hydraulic loading rate gives detention time, t, of pond which is the time required for BOD reactions to be completed and can be determined from the fundamental BOD equation i.e. $y=L\ (1-10^{-kt)}$

Where K= BOD removal constant

L= BOD load applied to the pond

y= BOD load satisfied in the pond

Table No.11 Design Criteria

Major Parameters	Aerobic Pond	Facultative Pond	Anaerobic Pond	Maturation Pond
Depth (m)	0.3-1.5	1.0-3.0	2.5-5.0	1.0-1.4
Detention Time (days)	4-40	5-30	15-50	5-18
Organic Loading (kg/ha/day)	40-160	15-150	200-500	0-15
BOD removal Efficiency (%)	80-85	80-95	50-80	60-80
Algal Concentration (mg/lit)	40-260	10-80	0-10	5-15

Disinfection- If the treated Storm water is to be used for irrigation, garden watering, street washing there is no necessity of disinfection. If required it can be done with proper amount of bleaching powder.

Storm water Lifting Mechanism

Hydraulic Ram-The hydraulic ram is an automatic pump which raises water without any external power for its operation. When large quantity of water is available at small height, it can be raised continuously to greater height with the help of hydraulic ram. The hydraulic ram utilizes the dynamic pressure of the liquid falling under a low head for lifting the liquid. It works on the principle of water hammer. It consists of a valve box 'B' fitted with a waste valve 'C' and delivery valve 'F'. The waste valve opens downward whereas the delivery valve opens upwards. An air vessel 'D' is fitted above the delivery pipe through a non-return valve. The supply pipe is connected at its upper end to the supply reservoir 'A' and its lower end to the valve box 'B'. The upper end of the delivery pipe is connected to the service tank 'E'.As the supply valve is opened, the liquid starts flowing down the supply pipe into valve box B. The waste valve C is open and the liquid flows through waste valve. As the rate of discharge increases, the dynamic pressure on the waste valve increases till the stage is reached at which the upward thrust on waste valve is greater than the weight of waste valve. At this stage, the waste valve closes suddenly. This sudden closing of waste valve brings the liquid in the supply pipe suddenly to rest. This causes water hammer and there is an increase of pressure in the valve box B. This increased pressure lifts the delivery valve F and some liquid enters in air vessel. The air in vessel is compressed. The increased air pressure in the air vessel forces some liquid to tank E through the non-return valve. When the momentum of the liquid in the valve box has thus been destroyed, the valve F closes and the valve C opens. The flow from tank A to the box B again commences and the cycle is thus repeated. The different parts of hydraulic ram are as follows

1. Supply Tank
2. Inlet Valve
3. Supply Pipe
4. Waste water chamber
5. Air Vessel
6. Delivery Pipe

VII. STORAGE OF TREATED STORMWATER-FLOATING TREATMENT WETLAND

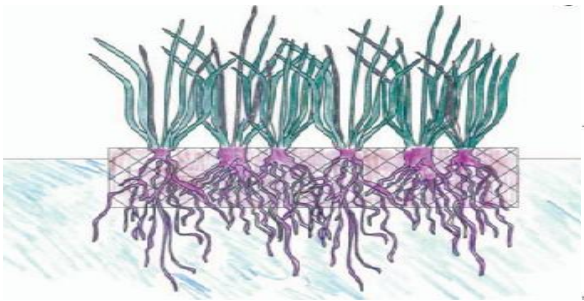

Fig. FTW Technique

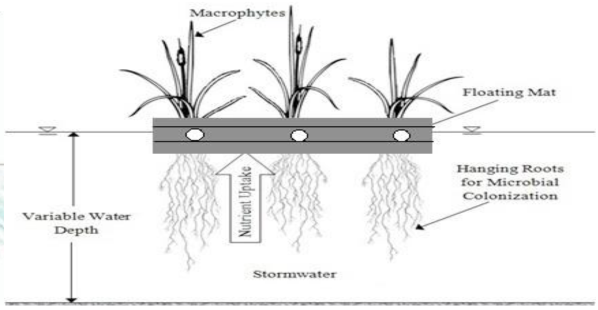

Fig. Hanging Root Colonization

FTW TECHNIQUE

Though the Storm water is treated by using stabilization ponds it is required to store treated Storm water in large ponds for longer duration. Therefore it needs long term treatment which will keep the stored water clean and to avoid unhygienic conditions. Hence one of the natural technique can be used i.e. **FTW Floating Treatment Wetlands** an Innovative Option for Storm water Quality.Ponds and wetlands have become widely accepted as urban Storm water treatment devices over the past two decades and are increasingly being integrated into water sensitive urban design practices. This growing popularity has been largely due to the fact that pond and wetland based systems offer the advantages of providing a relatively passive, low-maintenance and operationally simple treatment solution whilst potentially enhancing habitat and aesthetic values within the urban landscape. Floating Treatment Wetlands (FTWs) are an emerging variant of constructed wetland technologies which consist of emergent wetland plants growing hydroponically on structures floating on the surface of a pond-like basin.They represent a means of potentially improving the treatment performance of conventional pond systems by integrating the beneficial aspects of emergent macrophytes without being constrained by the requirement for shallow water depth. Despite the potential advantages of FTWs for the treatment of Storm water and other wastewaters, there has been very little information published to date about their design, construction and performance.

FTW Structure and Function-A FTW consists of emergent wetland vegetation growing on a mat or structure floating on the surface of a pond-like water body. The plant Stems remain above the water level, while their roots grow down through the buoyant structure and into the water column. In this way, the plants grow in a hydroponic manner, taking their nutrition directly from the water column in the absence of soil. Beneath the floating mat, a hanging network of roots, rhizomes and attached biofilms is formed. This hanging root-biofilm network provides a biologically active surface area for biochemical processes as well as physical processes such as filtering and entrapment. Thus, a general FTW design objective is to maximize the contact between the root-biofilm network and the polluted water passing through the system.

Surface Coverage and Shading-The coverage of pond surface provided by the floating mat minimizes light penetration into the water column, thereby limiting the potential for algae growth. This will also have an impact on the composition of the biofilm community that develops within the network of roots under the floating mat. With the exception of the edges of the floating mats where there will be some light penetration, biofilms will be composed predominantly of non-photosynthetic bacterial communities. This will have an effect on the physico-chemical conditions that develop in the water column (e.g. dissolved oxygen and pH) and some of biogeochemical processes affecting treatment within the FTW (e.g. the role played by algae in nutrient and element cycling).

Floating Treatment Wetland

VIII. ADVANTAGES OF FTWs FOR STORMWATER TREATMENT

1. Tolerance of variable water depths-One of the main advantages of FTWs over conventional sediment-rooted wetlands is their ability to cope with the variable water depths that are typical of event-driven Storm water systems. Because they float on the water surface, the plants in a FTW are not affected by fluctuations in water levels that may submerse and adversely stress bottom rooted plants in Storm water systems. This also allows for the FTW to be designed to operate as an extended detention basin so that large runoff events can be captured and slowly released over several days, thereby increasing the proportion of storm flow that receives treatment.

2. Increased areal efficiency-By deepening the wetland, the effective volume of the treatment system is increased (compared to conventional wetland systems), thereby lengthening the amount of time that water spends within the system (i.e. the hydraulic retention time) without necessarily increasing its footprint. For many pollutants, particularly those involving time dependent chemical or biological reactions, the retention time plays an important role in determining the level of treatment. Compared to ponds, FTWs have the advantage of the additional surface area provided by the floating mat and root network for the establishment of attached growth microbes (biofilms) that are responsible for many of the desirable treatment processes. The ability of loading treatment wetlands to operate at greater water depths than conventional wetlands may mean that they are capable of achieving a higher

Level of treatment per unit surface area (increased areal efficiency) for certain pollutants.

3. Long-term management of accumulated solids and sludge-In surface flow and subsurface flow wetlands the accumulation of solids and sludge occurs integrally within the plant-substrate matrix where it cannot easily be removed, and therefore imposes a design and dimensioning limitation. By comparison, the ultimate long-term sink for solids in a FTW is in the sediments on the bottom of the underlying basin, segregated from the floating mat and associated plants. Thus, there is greater potential for this accumulated sediment to be excavated from the system without substantially disturbing or damaging the system (assuming the entire water surface is not covered with floating mat).

4. Plant uptake-It is conceivable that plant assimilation of nutrients and other elements, such as metals, may be higher in a floating wetland system compared to a sediment-rooted wetland, as the roots hanging beneath the floating mat are in direct contact with the Storm water to be treated. Furthermore, the plant roots are not in contact with the bottom sediments or soil and only have access to nutrients contained within the floating mat and in the water column, much like a hydroponic cultivation system

5. Flexible modular construction-Depending on the materials and structure used, floating wetlands are particularly suitable for modular applications, where the number (and % coverage) of floating wetlands can be easily increased in order to improve treatment performance if necessary (providing sufficient basin area is available). It should also be possible to have an influence over the ambient physico-chemical conditions that develop in the water column by varying the percentage of water surface that is covered and the configuration of this cover (i.e. continuous cover versus a patchwork of open water and cover). For example, open water zones provide greater opportunity for air diffusion and phytoplankton photosynthesis, both of which effect the DO concentration and pH of the water column and may be used to promote or inhibit certain treatment processes. Conversely, excessive coverage of FTW can lead to deoxygenating of the water column which may have negative impacts on downstream biota or possibly lead to release of phosphorus from anaerobic sediments.

6. **Aesthetic enhancement of ponds-**Floating wetlands may be perceived to enhance the aesthetic values of a Storm water treatment pond, depending on the shape, structure and vegetation used. There may also be some additional benefits in terms of provision of habitat for wildlife, such as birds. A floating wetland can provide protection for birds against some predators. However, the attraction of wildlife may also have deleterious effects on water quality through the introduction of faecal material, nutrients and disturbance. Excessive bird numbers can also lead to vegetation decline due to overgrazing and trampling and make it difficult to initially establish plants on the floating structure.

IX. CONCLUSION

1. The study of project reveals that the Storm water, instead of wasting can be utilized for various purposes like gardening, fire fighting, street washing, irrigation.
2. The Storm water can be given low cost treatment such as stabilization ponds which can reduce BOD, COD, and Total solids and increase DO for its long term use.
3. It is studied that at nodes the nallahs are inadequate; hence it is necessary to redesign some nallahs without any change in their initial invert levels to attain good efficiency of drains.
4. It is observed that there is so much deposition of silt and waste materials along the sections, which results in water logging problems during rainy season. The silt can be trapped at appropriate places by constructing check dams.
5. Water conservation. Water that is stored in retention ponds is available for non-potable human uses such as irrigation through which Corporation may get revenue by supplying stored water for irrigation during summer.
6. Flood prevention. Rain gardens collect, temporarily store and eventually absorb Storm water runoff, making flood events less likely.
7. Due to Proper Management of Storm Water, Low lying areas will not be flooded due to which unhygienic conditions will be reduced to great extent. It will also reduce deceases which occur due to mosquitoes, flies and traffic inconvenience.

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