MUNICIPAL & INDUSTRIAL WASTEWATER ENGINEERING

17CV71

17CV71 **MUNICIPAL AND INDUSTRIAL WASTE WATER ENGINEERING**

Credits: 4 **Total:** 50hrs
Exam Marks: 60 **IA Marks:** 40
Exam: 4hrs **Lecture:** 3hrs

MODULE 1

Introduction, need for sanitation, methods of sewage disposal, types of sewerage systems, dry weather flow, wet weather flow, factors effecting dry and wet weather flow on design of sewerage system, estimation of storm flow, time of concentration flow, material of sewers, shape of sewers, laying and testing of sewers, ventilation of sewers. low-cost waste treatment; oxidation pond, septic tank, Sewer appurtenances, manholes, catch basins, basic principles of house drainage, typical layout plan showing house drainage connections,

10hrs

MODULE 2

Design of sewers, hydraulic formula for velocity, effects of variation on velocity, regime velocity, design of hydraulic elements for circular sewers for full flow and partial flow conditions, disposal of effluents by dilution, self purification phenomenon, oxygen sag curve, zones of purification, sewage farming, sewage sickness, numerical problems on disposal of effluents, Streeter-Phelps equation

10hrs

SYLLABUS

MODULE 3

Waste water characteristics, sampling, significance and techniques, physical, chemical and biological characteristics, flow diagram for municipal waste water treatment, unit operations; screens, grit chambers, skimming tanks, equalization tanks Suspended growth and fixed film bio process, design of trickling filters, activated sludge process, sequential batch reactors, moving bed bio reactors, sludge digesters

10hrs

MODULE 4

Difference between domestic and industrial waste water, effect of effluent discharge on streams, methods of industrial waste water treatment; volume reduction, strength reduction, neutralization, equalisation and proportioning. Removal of organic, inorganic and colloidal solids, combined treatment methods; merits, demerits and feasibility, principles of discharge of raw, partially treated and completely treated wastes in to streams

10hrs

SYLLABUS

MODULE 5

Process flow chart, sources and characteristics of industrial waste water, treatment methods, reuse and recovery and disposal; cotton and textile industry, tanning industry, cane sugar and distilleries, dairy industry, steel and cement industry, paper and pulp industry, pharmaceutical and food processing industry.

10hrs

SANITATION & ITS NEED

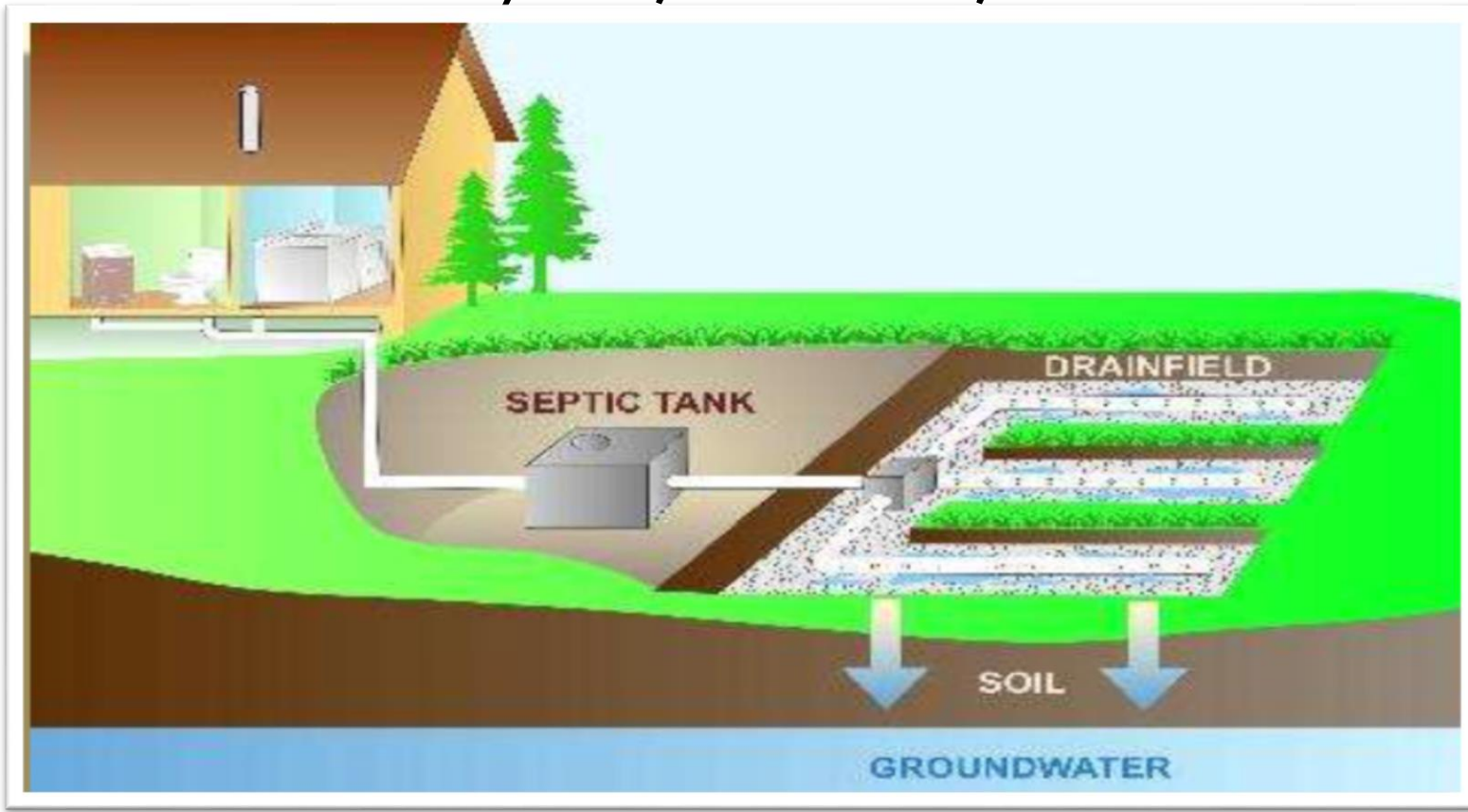
- Sanitation - public health conditions related to clean drinking water and adequate treatment and disposal of human excreta and sewage Sanitation systems aim to protect human health by providing a clean environment that will stop the transmission of disease
- Water is a basic necessity, and an important resource for sustaining life. The decline in water quality endangers the health of humans as well as the ecosystem. Clean drinking water, hygiene, and sanitation play an important part in maintaining health.
- Contaminated water causes many water-borne infections like diarrhoea, and also serves as a carrier for vectors such as mosquitoes spreading epidemics. Open defecation means no sanitation. It fouls the environment, and spreads diseases.

SANITATION & ITS NEED

- Sanitation is important for all, helping to maintain health and increase life-spans. However, it is especially important for children. Around the world, over 800 children under age five die every day from preventable diarrhea-related diseases caused by lack of access to water, sanitation and hygiene. In addition, diarrhea causes children to lose their appetites, which can lead to malnourishment. Limited access to sanitation has become such a worldwide problem that 1 in every 4 children suffer from stunted growth. This leads to "irreversible physical and cognitive damage."
- Sanitation makes a positive contribution in family literacy. According to a UNICEF study, for every 10 per cent increase in female literacy, a country's economy can grow by 0.3 per cent. Thus, sanitation contributes to social and economic development of the society. Improved sanitation also helps the environment.
- Sanitation brings numerous benefits such as reducing the burden of disease, improving quality of life, promoting the safety of women and girls, not to mention the excellent economic investment that sanitation represents.

CONSERVANCY SYSTEM

- Also called dry-System. practice from very ancient times. Actually it is out of date system even though it is prevailing in small towns, villages and undeveloped portions of the large cities.
- Various types of refuse and storm water are collected, conveyed and disposed of separately by different methods in this system, therefore, it is called conservancy system.



- Garbage or dry refuse of a town is collected in dust bins placed along the roads and streets, from where it is conveyed by trucks or covered carts once or twice in a day to the point of disposal.
- Non-combustible portions of the garbage such as sand, dust, clay ashes etc., are used for filling the low level areas to reclaim land for further development of the town.
- The combustible portion of garbage such as dry leaves, waste paper, broken furniture etc. are burnt. The decaying fruit and vegetables, grass and other things are first dried and then disposed of by burning or in the manufacturing of Manure.
- Human Excreta or Night Soil is collected separately in privies or conservancy laterins. The liquid and semi-liquid wastes are collected in separate drains of the same latrine, from where they are removed through human agency. The night soil is taken outside the town in closed animal drawn carts, trucks or tanks mounted on the trailers. The night soil is buried in trenches.
- • Sullage and Storm waters are also carried out separately in closed or open drains, upto the point of disposal, where they are allowed to mix with stream, rivers or sea without any treatment

MERITS OF CONSERVANCY SYSTEM

- It is cheaper in Initial cost because storm water can pass in open drains and conservancy latrines are much economical.
- The quantity of sewage reaching at the treatment plant before disposal is low.
- As the storm water goes in open drains, the sewer section will be small and will run full for the major portion of the year, due to which there will be no silting and deposits in sewer-lines.
- In floods if the water level of river rises at the out-fall, it will not be costly to pump the sewage for disposal

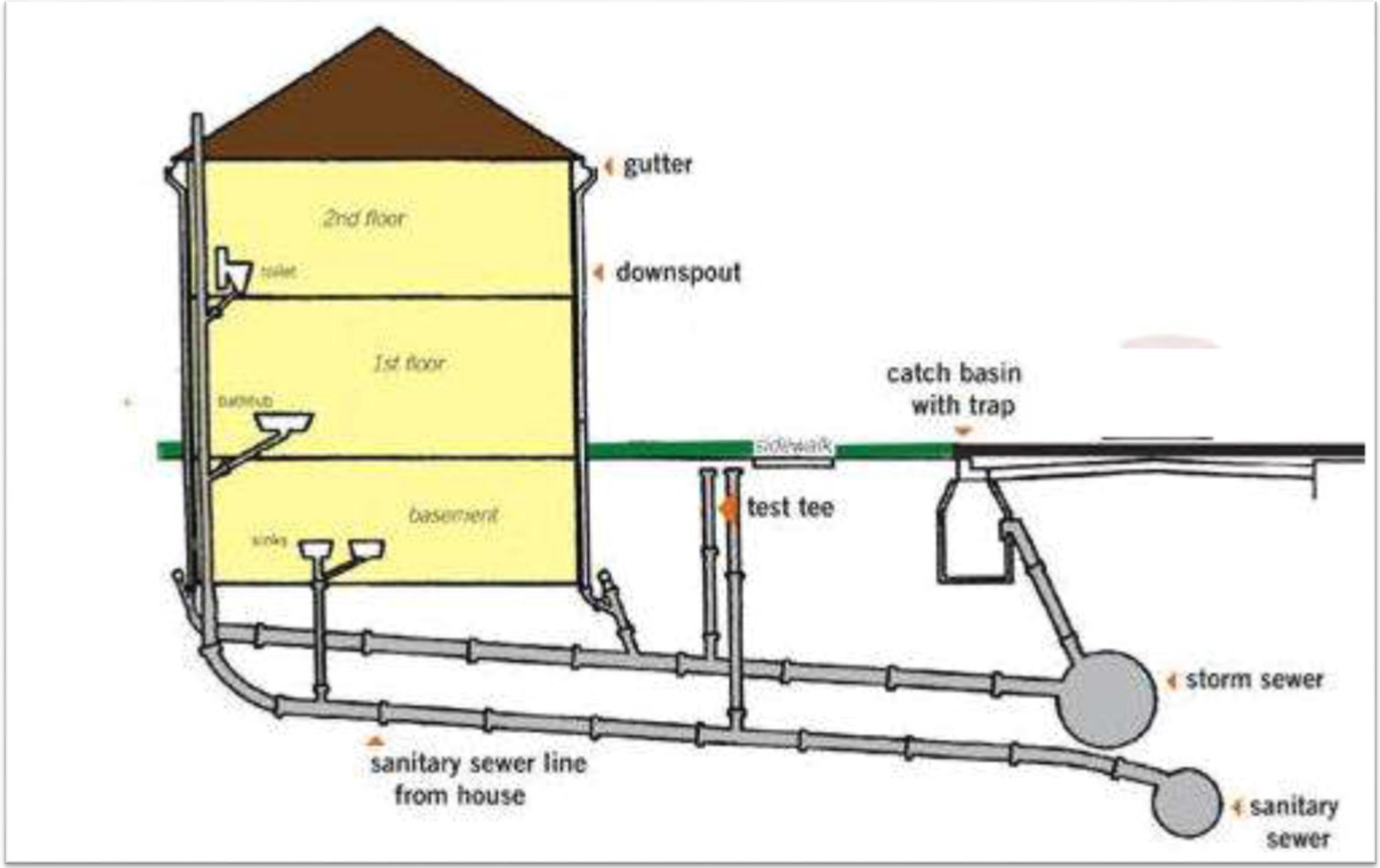
DEMERITS OF CONSERVANCY SYSTEM

- It is possible that storm water may go in sewer causing heavy load on treatment plants, therefore it is to be watched.
- • In crowded lanes it is very difficult to lay two sewers or construct road side drains, causing great inconvenience to the traffic.
- • Buildings cannot be designed as compact unit, because latrines are to be designed away from the living rooms due to foul smell, which are also inconvenient.
- • In the presence of conservancy system, the aesthetic appearance of the city cannot be increased.
- • Decomposition of sewage causes insanitary conditions which are dangerous to public health.
- • This system completely depends on the mercy of sweepers

WATER CARRIAGE SYSTEM

- With the development and advantages of the cities, urgent need was felt to replace conservancy system with some more improved types of system in which human agencies should not be used for the collection and conveyance of the sewage. After a large number of trials it was found that the water is the only cheapest substance, which can be easily used for collection and conveyance of sewage. Therefore it is called Water-Carriage System.

- In this system the excremental matters are mixed up in large quantity of water and are disposed off after necessary treatment in a satisfactory manner.


gutter
2nd floor
toilet
downspout
1st floor
bathtub
catch basin
with trap
sidewalk
test tee
basement
sinks
storm sewer
sanitary sewer line
from house
sanitary
sewer

MERITS

- It is hygienic method, because all the excremental matters are collected and conveyed by water only and no human agency is employed for it.
- There is no nuisance in the street of the town due to offensive matters, because all the sewage goes in closed sewers under the ground. The risk of epidemic is reduced.
- As only one sewer is laid, therefore it occupies less space in crowded lane.
- Due to more quantity of sewage, self-cleansing velocity can be obtained even at less gradients.
- Buildings can be designed as compact one unit.
- The land required for the disposal work is less as compared with conservancy system in which more area is required

- The usual water supply is sufficient and no additional water is required in water carriage system.
- This system does not depend on the manual labours
- Sewage after proper treatment can be used for various purposes.

DEMERITS

- This system is very costly in initial cost.
- The maintenance of this system is also costly.
- During monsoon large volume of sewage is to be treated whereas very small volume is to be treated in the remaining period of the year.

SEWERAGE SYSTEMS:

CONSERVENCY SYSTEM	WATER CARRIAGE SYSTEM
Very cheap in initial cost.	It involves high initial cost.
Due to foul smells from the latrines, they are to be constructed away from living room so building cannot be constructed as compact units.	As there is no foul smell latrines remain clean and neat and hence are constructed with rooms, therefore buildings may be compact.
The aesthetic appearance of the city cannot be improved	Good aesthetic appearance of city can be obtained.
For burial of excremental matter large area is required.	Less area is required as compared to conservancy system.
Excreta is not removed immediately hence its decomposition starts before removal,	Excreta are removed immediately with water, no problem of foul smell or hygienic trouble.
This system is fully depended on human agency .In case of strike by the sweepers; there is danger of insanitary conditions in	As no human agency is involved in this system ,there is no such problem as in case of conservancy system

Collection of Sewage

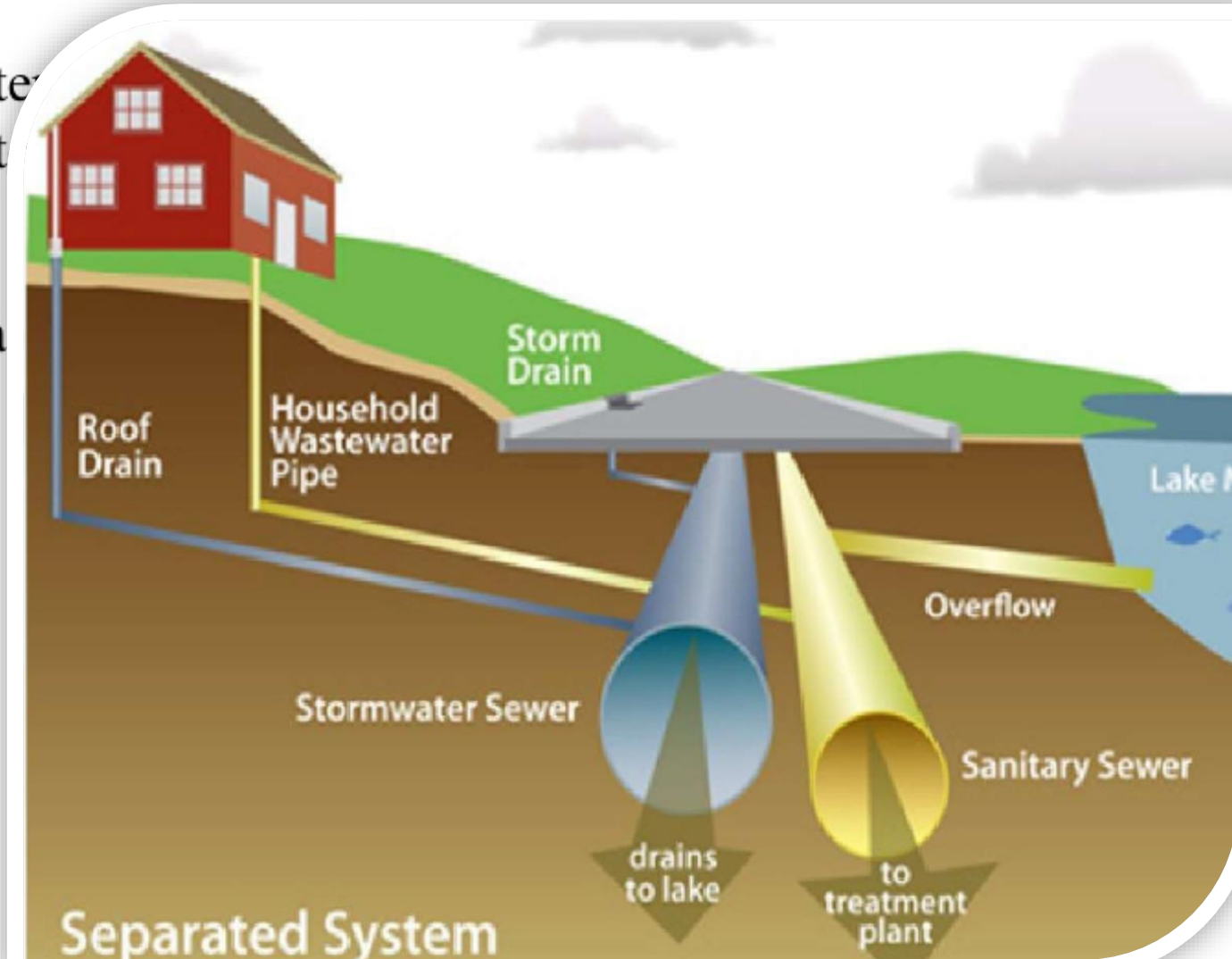
A system of sewer pipes (sewers) collects sewage and takes it for treatment or disposal. The system of sewers is called *sewerage* or *sewerage system,*

Where a main sewerage system has not been provided, sewage may be collected from homes by pipes into septic tanks or cesspits, where it may be treated or collected in vehicles and taken for treatment or disposal.

Sewerage system, network of pipes, pumps, and force mains for the collection of wastewater, or sewage, from a community.

1. Separate Sewerage System

- In this system the sanitary sewage and storm water are carried separately in two sets of sewers.
- The sewage is conveyed to waste wate treatment plant (WWTP) and the storm wat is discharges into rivers without treatment.
- The separated system is suitable when separa outlet for storm water is available and the topography is such that storm water can be disposed of in natural drains



Advantages of Separate System

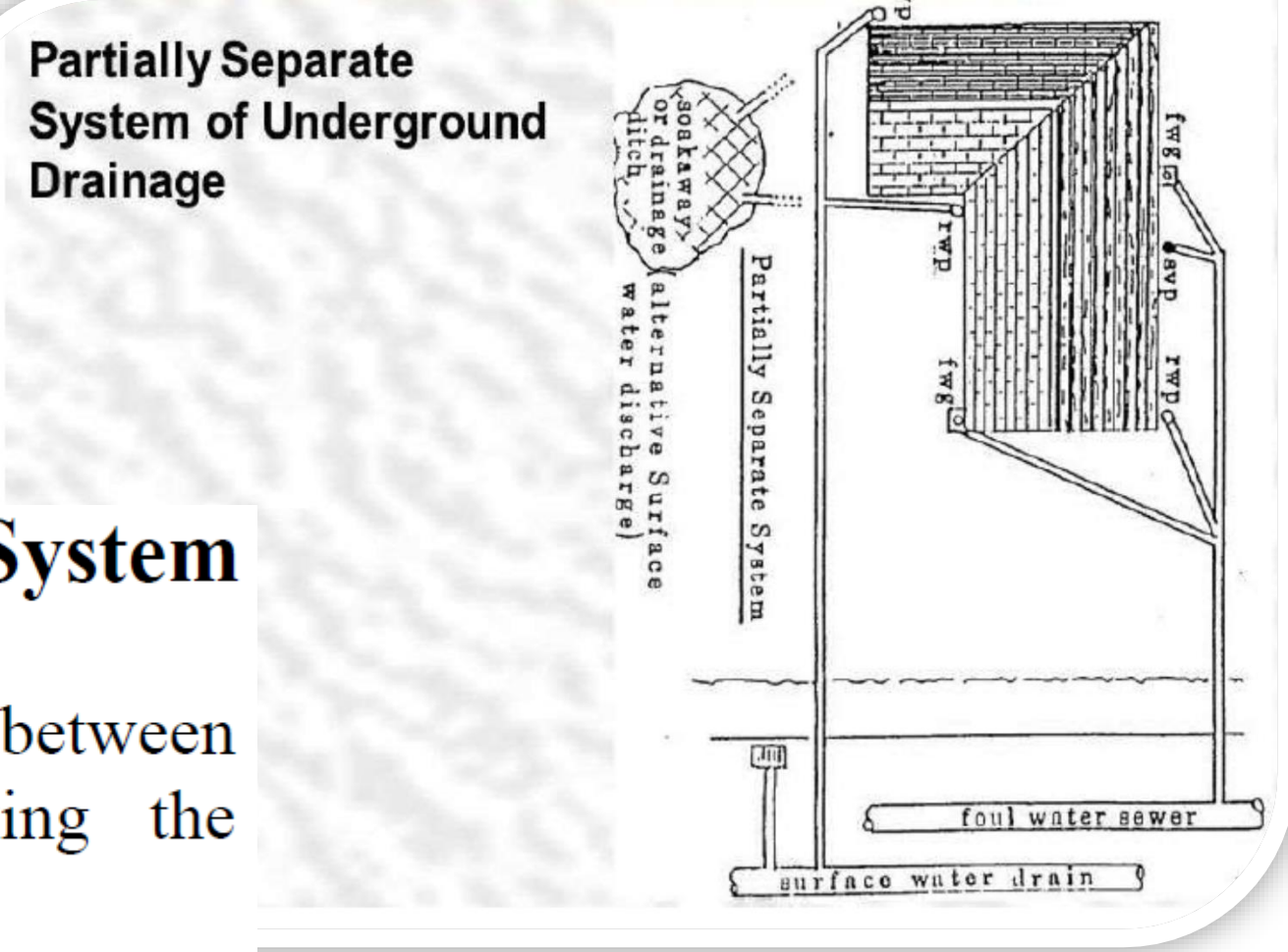
- The load on treatment plant is less as only sewage is carried to the plant.
- The size of sewer is small, thus economical
- When pumping is required, the system proves to be economical.
- Natural/storm water is not unnecessarily polluted by sewage.

Disadvantages of Separate System

- Cleaning of sewer is difficult due to their small size.
- The self cleansing velocity is not easily obtained.
- The storm sewers come in operation in rainy season only. They may be chocked in dry season by garbage.
- Maintenance cost is high.
- Sewage sewers are provided below storm sewer which causes greater depth and pumping at waste water treatment plant (WWTP).

2. Partially Separate Sewerage System

- This system is the compromise between separate and combine system taking the advantages of both systems.
- In this system the sewage and storm water of buildings are carried by one set of sewers while the storm water from roads, streets, pavements etc are carried by other system of sewers usually open drains.



Advantages of Partially Separate Sewerage System

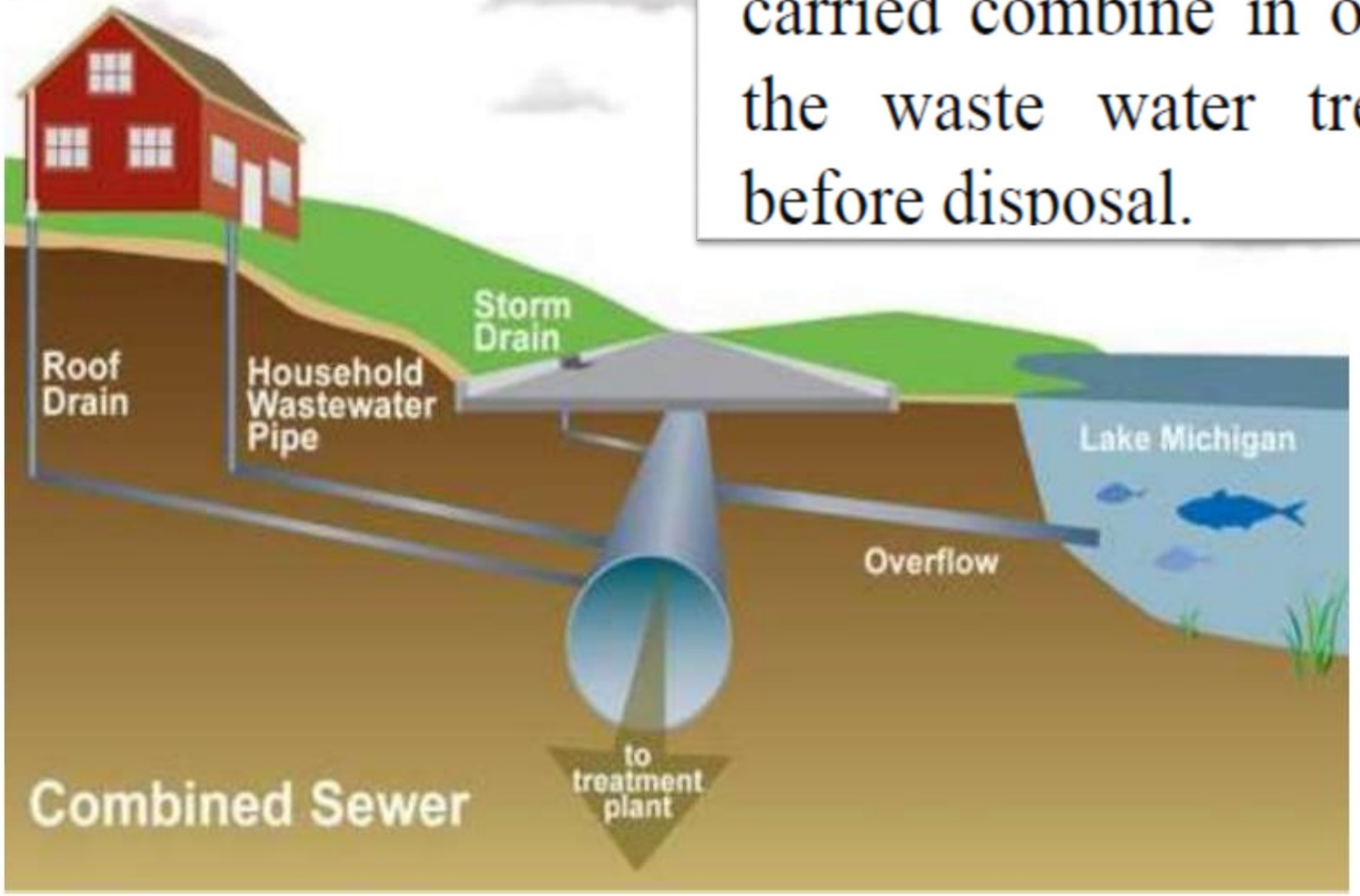
- It combines the good features of both systems.
- The silting is avoided due to entry of storm water.
- The storm water from houses is easily disposed off.
- The sewers are of reasonable size.

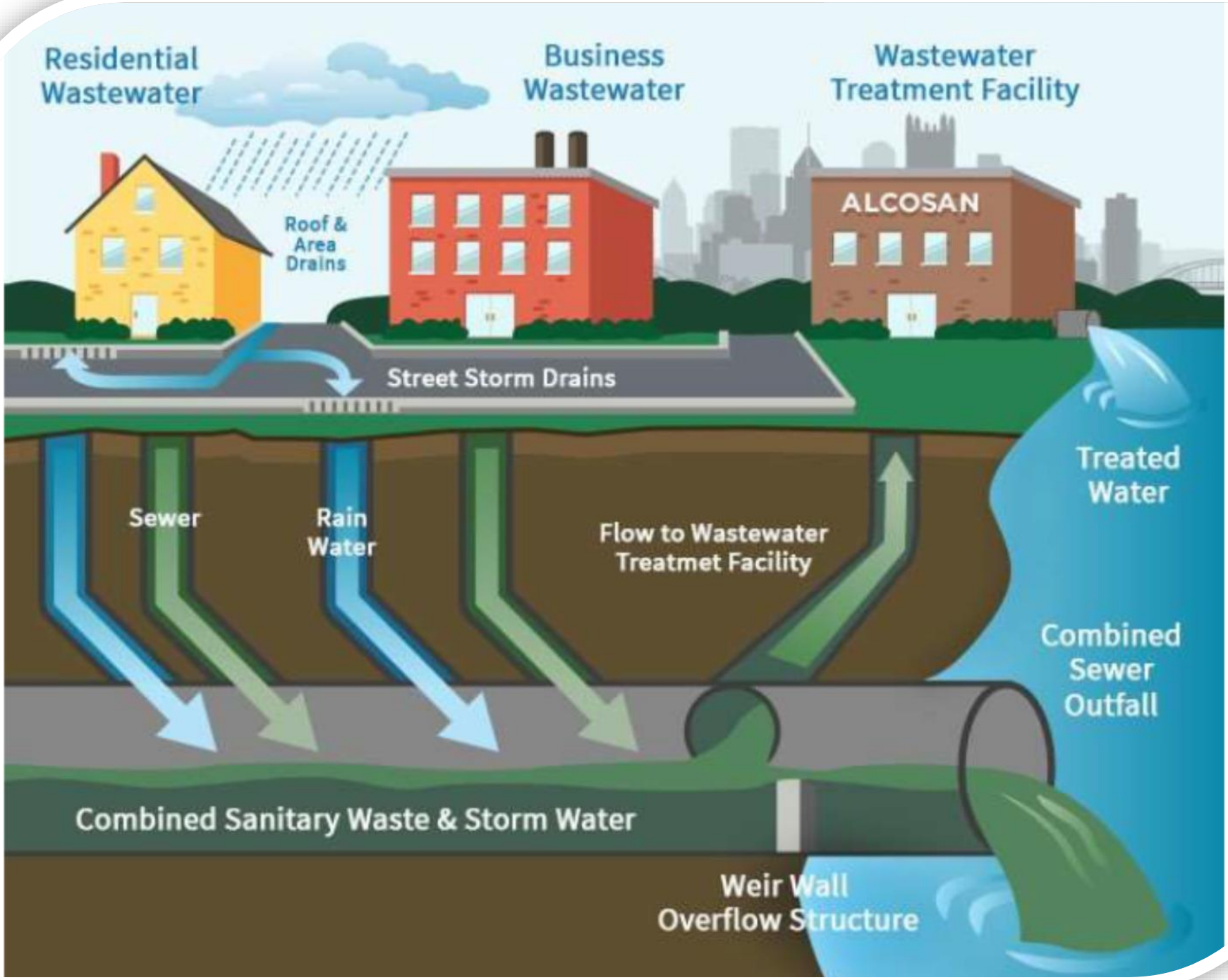
Disadvantages of Partially Separate Sewerage System

- A very small fraction of bad features of combined system are there in partially separated system.

3. Combined Sewerage System

In this system the sewage and storm water are carried combine in only one set of sewers to the waste water treatment Plant (WWTP) before disposal.




Residential Wastewater
Business Wastewater
Wastewater Treatment Facility
ALCOSAN
Roof & Area Drains
Street Storm Drains
Treated Water
Sewer
Rain Water
Flow to Wastewater Treatmet Facility
Combined Sewer Outfall
Combined Sanitary Waste & Storm Water
Weir Wall Overflow Structure

Advantages of Combined Sewe System

- Easy cleaning because of larger diamete
- Reasonable maintenance cost.
- Strength of sewage is reduced due to dilution of sewage by storm water.
- This system requires only one set of sewer making it economical.

Disadvantages of Combined Sewerage System

- In storm season sewer may overflow and the sewer may damage causing serious health risks
- The combine sewer gets silted and becomes foul in dry days
- Load on treatment plant is more because storm water is also carried there
- The storm water gets polluted unnecessarily
- The system becomes uneconomical when pumping is needed

Why Estimation of Wastewater Discharge Required?

- Under Estimation Would Result In Less Diameter Of Sewer Causing The Overflow Problems.

- Over estimation of wastewater flow would result in a sewer of large diameter which would increase the cost of sewerage system.

Wastewater Discharge

- Dry Weather Flow
  - The Flow which always available through out the year.
  - It is the summation of domestic supply and industrial supply.
- Wet Weather Flow
  - It consist the combination of **Dry Weather Flow** And The **Storm Water flow.**
  - It is generally estimated when the combine sewerage system has adopted.

Estimation of Dry Weather Flow

- Domestic Wastewater
- Industrial Wastewater
- Ground water Infiltration in to Sewer through Joints.

Thumb Rule : Wastewater generated from a city is the 80% of the water supplied.

Factors Affect to DWF

- Rate of Water Supply
- Area Served
- Population Growth
- Infiltration as well as Exfiltration

Area Served

- Waste water generated in residential area depends upon the water supplied per capita per day.
- Waste water generated in Industrial area depends upon the type of industries.

Sr no.	Name of Industry	Unit of Production	Wastewater generation
1	Milk Production	Ton	20000
2	Steel	Ton	260000
3	Bread	Ton	2100-4200
4	Automobile	Vehicle	40000
5	Sugar	Tonne Cruched	1000 to 2000
6	Textile	100 kg	8000 to 14000

RATE OF WATER SUPPLY

- The rate of water supply to a cityltown is expressed so many litres/capita/day.
- The quantity of waste water entering the sewers would be less than the total quantity of water supplied.
- This is This is because of the fact that water is lost in domestic consumption, evaporation, lawn sprinkling. fire fighting, industrial consumption. However, private source of water supply(i e. water from domestic wells etc.) and infiltration of sub-soil water in the sewers increase the waste water flow rate.

Population Growth

- Wastewater treatment plant should also consider population forecasting for design period.
- Waste water treatment projects designed to serve for a period of 30 years.
- Design Period should neither be too long nor to short
- It should note exceed the useful life of the component structure or equipment.

Infiltration

- Ground Pressure higher than pressure inside the sewer, thus Ground water entered in inside the sewer known as infiltration.
- Depth of Sewer below the ground water level.
- Size and length of sewer
- Nature and type of soil
- Workmanship during lying off sewer.

Exfiltration

- Inside Sewer Pressure higher than outside Ground water, sewage shall leak out of the sewer through the faulty joints.
- There is addition in sewage due to unaccounted private water supplies.
- The Additional in sewage due to infiltration.
- Water losses due to leakage
- Some water is not entering the sewerage system e.g. gardening, garages for washing cars,etc

WET WEATHER FLOW (WWF)

- Storm water flow is also known as Wet Weather Flow (WWF)
- When rainfall takes place, a part of it infiltrates or percolates into the ground surface while the remaining flows over the land depending upon permeability of the ground, its surface slope and many other factors.
- The amount of water flowing over the ground surface, pavements, house roofs etc. is commonly known as 'runoff or the storm water.
- This storm water is ultimately drained through the sewers, otherwise the streets, roads etc. would be flooded.

RUNOFF/STORM WATER FLOW/WWF DEPENDS ON

(i) Catchment area

(ii) Ground slope

(iii) Permeability of ground

(iv) Extent of impervious area such as buildings, paved yards, non-absorbent road surface etc.

v) Extent of vegetation growth

vi) Rain fall intensity

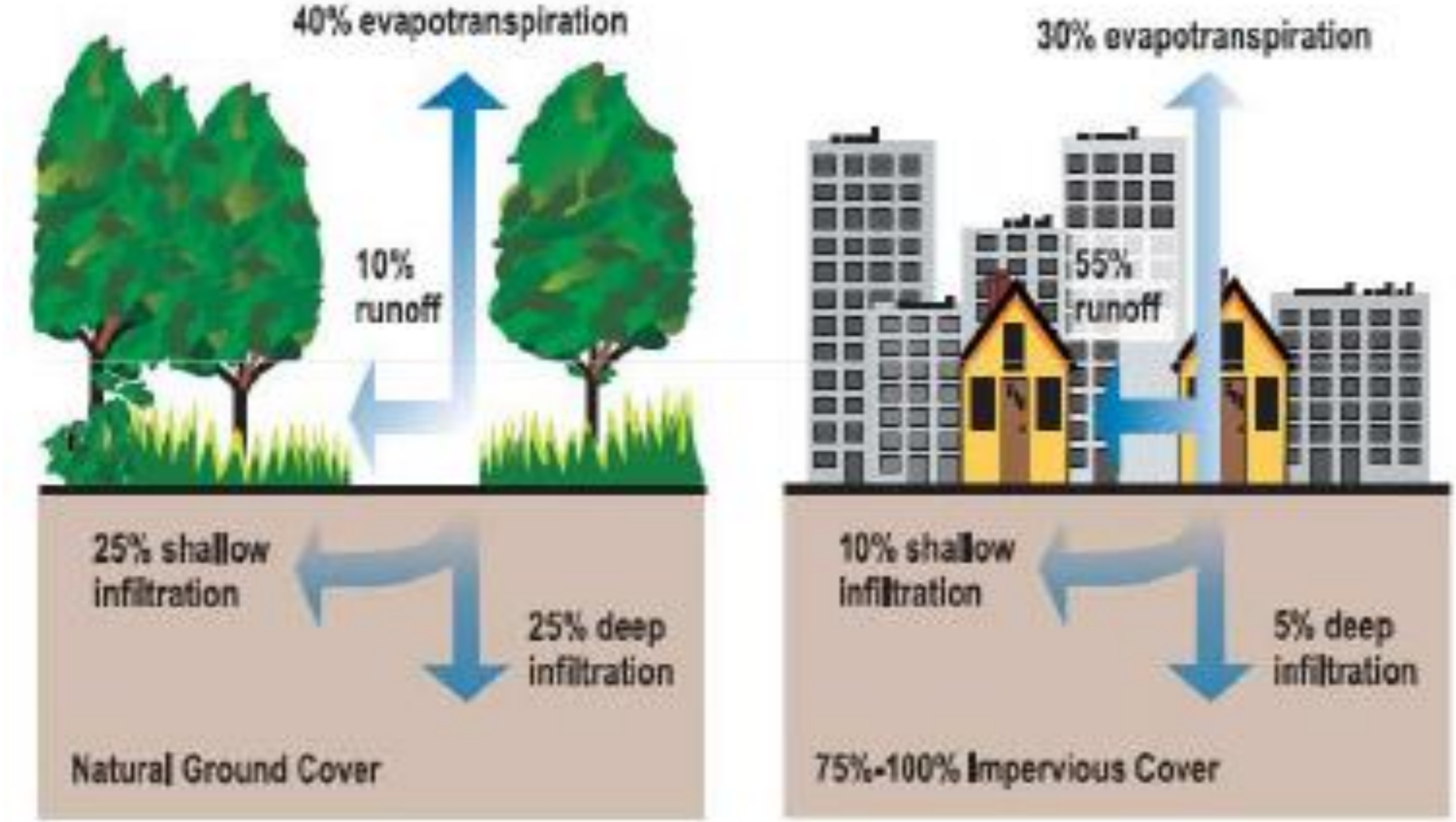
vii)Rainfall duration

viii) Condition of ground prior to the rainfall

ix) Concentration or compactness of

catchment area.

x) Climatic conditions such as wind, humidity, temperature etc.


40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover
30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Cover

ESTIMATION OF STORM WATER FLOW

1.RATIONAL METHOD

The rational formula is most commonly used for design of storm drains. In takes into account the following three factors:

(i) Catchment area (*A)*

(ii) Impermeability factor (I) of the catchment area.

(iii)Intensity of rainfall *(R)*

This formula can be used only when catchment area is smaller than 400 hec

THE RATIONAL FORMULA

$$Q = K.A.I.R_i$$

Q = run off or storm water flow

K = constant which permits the expression of the factors A, I and R in convenient units.

Let, Q = runoff in cubic meters per second (cumec)

A = catchment area in hectares

Ai = impervious area = A x I

Ri = Intensity of rainfall in mm per hour.

I = impermeability coefficient

AVERAGE IMPERMEABILITY FACTOR

Let, $A_1, A_2, \ldots\ldots\ldots A_n$ = areas of the different surface of the catchment area.

$I_1, I_2, \ldots\ldots\ldots In$= Corresponding impermeability factors for different surfaces.

Impermeable area = $A_1I_1+A_2I_2+\ldots\ldots\ldots\ldots+A_nI_n=\Sigma A.I$

Hence , average impermeability factor

$$I_{avg} = (\Sigma A.I)/(\Sigma A)$$

(a) *General formula* :

$$R_i = \frac{25.4\,a}{t + b} \qquad \ldots(3.7)$$

where R_i = rainfall intensity in mm/hour.

t = duration of storm in minutes ≈ time of concentration.

a , b = constants.

The United States Ministry of Health recommend the following values of constants a and b

Duration of storm	*constant a*	*constant b*
5 to 20 min.	30	10
20 to 100 min.	40	20

2.EMPIRICAL FORMULAE

If catchment area is more than 400 hec. Then following empirical formulae can be used.

i. Dicken's formula

ii. Ryve's formula

iii. Inglis's formula

iv. Talbot's formula

v. Fanning's formula

vi. Metcalf Eddy's formula

vii. McMath formula

viii. Burkli-Zeiglar formula

Time of concentration (t_c)

- Time required for the entire catchment to contribute to runoff at the point of interest for hydraulic design
  - time taken for the most hydraulically remote point of the catchment to contribute storm water to the outlet
- t_c of 10 to 300 minutes is acceptable for application in the rational method
  - for t_c <10 min., the rainfall intensity is unacceptably high
  - for t_c >300, the assumption of steady rainfall is less valid
- Factors affecting the t_c
  - Ponding, surface roughness and catchment slope
  - Fraction of impervious area and fraction of area directly connected to flow
  - Flow path length, channel slope, channel shape and flow pattern
- Urbanization decreases t_c