



**INSTITUTE OF AERONAUTICAL ENGINEERING
(AUTONOMOUS)
Dundigal, Hyderabad- 500 043**



**ENVIRONMENTAL
ENGINEERING
(ACE015)
IARE-R16 B.Tech VII SEM**

Prepared By:

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Department of Civil Engineering

Course goal

- To introduce properties of concrete and its constituent materials and the role of various admixtures in modifying these properties to suit specific requirements, such as ready mix concrete, reinforcement detailing, disaster-resistant construction, and concrete machinery. These have been treated exhaustively and also special concrete in addition to the durability, maintenance, and quality control of concrete structure.

Course objectives

At the end of the course, the students will be able to:

- I. Outline the different sources of water and its per capita demand.
- II. Describe the basic characteristics of water and study the procedure for determination
- III. Design the water supply lines, water collection and different distribution networks.
- IV. Construct and design waste water treatment units such as oxidation ponds, sludge digestion tanks, soak pits etc.

UNIT 1

WATER QUALITY DEMAND AND SUPPLY

Waste water

Introduction to wastewater–Sewage: • Definition of sewage, Necessity of sewage Treatment, Requirement of a sewage management System, Composition of Sewage ”

History:

•Characterization and Disposal: Characteristics of sewage: Composition, chemistry of sanitary sewage, B.O.D, C.O.D aerobic and anaerobic decomposition, Sewage Disposal Discharge of raw and treated sewage on land and water, standards for disposal, raw and treated sewage on land and water, limit of dilution, self-purification of streams, oxygen economy,sewage farming

Waste water

- Wastewater: Water when used for different purpose like domestic commercial, industrial etc., receives impurities and become wastewater. Thus wastewater is used water and it has physical, chemical, and biological Impurities wastewater is a general term.
- Sewage: The waste water coming from W.C. and containing human excreta is known as sewage

Definition of Terms

- Sullage: The Wastewater coming from bathrooms and kitchens which does not contain fecal matter is known as sullage
- Plumbing System: It is entire system of pipe line for providing water supply to the building or it is a system of pipes for disposal of wastewater from the building
- Sewer: A pipe carrying sewage/ wastewater is called sewer

Definition of Terms

- **Soil Pipe:** It is pipe carrying sewage from W.C.
- **Waste Pipe:** It is a pipe carrying silage from bathrooms, kitchens, sinks, wash basins, etc.
- **Sewerage System:** A system of sewers of different types and sizes in a town collecting wastewater from the town and carrying it to the wastewater treatment plant

Types of Cement :

Characteristics of Wastewater



Environmental Engineering
Unit-I



Necessity of Sewage Treatment

- Waste matter from domestic or industrial establishments that is carried away in sewers or drains for dumping or conversion into a form that is nontoxic
- The treatment of sewage water has become the need of the hour as it stops spreading the diseases and illness caused by the sewage water.
- It helps society in making the water as well as environment clean.
- The sewage treatment plant works composed of 3. The three stages of these plants include the primary stage, the secondary stage and the tertiary stage

Necessity of Sewage Treatment

- In the primary stage, the contaminants that are easy to eliminate are taken out from the wastewater. These substances may include oils, grease, and fats that can be easily removed from the surface area. The solids things like grits, stones, rocks, etc. are strained
- At the secondary stage, the removal of biological contaminant in waste water takes place

Necessity of Sewage Treatment

- At the tertiary treatment, which is the last stage of the plant, the water is get cleaned purely to get discharged in the environment. This is composed of man-made or artificial systems that help in filtration. At this stage, the nitrogen and phosphorous content is eliminated from the water. In addition to this, the water is further disinfected using chemicals like chlorine as well as treatment of UV.

The Importance of Managing Sewage

- The scope of sewage management has evolved throughout history with changes in socioeconomic conditions, city structures, and the environment. Today, sewage infrastructure that is well planned and operated supports urban sanitation and related activities. Effective sewage management is essential for nutrient recycling and for maintain in ecosystem
 - Preventing floods through removal of rainwater
 - Preserving receiving water quality

Composition of sewage

Soluble inorganic material such as ammonia, road-salt, seasalt, cyanide, hydrogen sulfide, thiocyanates, thiosulfates, etc.;

- Animals such as protozoa, insects, arthropods, small fish, etc.;
- Macro-solids such as sanitary napkins, nappies/diapers, condoms, needles, children's toys, dead animals or plants, etc.;

Introduction

- Wastewaters are usually classified as industrial wastewater or the domestic wastewater (sewage or municipal wastewater).
- Characteristics of industrial wastewater vary greatly from industry to industry and within industries also there are variations in the quality depending up on the processes, for example quality of wastewater.

INTRODUCTION

- Sewage contains organic and inorganic matter, some gases and living organisms (mainly microorganisms) the organic and inorganic matter may be dissolved, suspended, and colloidal state
- The inorganic matter consists of ash, cinders and grit, mud and other mineral salts.
- The organic matter may be nitrogenous or nitrogen free. Gases include methane (CH_4), hydrogen sulphide (H_2S), carbon dioxide (CO_2) etc. Sewage contains only a small percentage of solids i.e 0.1% while remaining 99.9% is water

Decomposition of Sewage

- Most of the organic matter present in sewage is unstable and decomposes readily through chemical as well as the biological processes. The organic matter, which can be decomposed by bacteria under biological action, is called biodegradable organic matter. Most of the organic matter present in sewage is biodegradable and hence undergo biological.

Anaerobic Decomposition

- Anaerobic bacteria and facultative bacteria operating anaerobically, will then flourish and convert the complex organic matter into simpler organic compounds of nitrogen, carbon, and sulphur.
- These anaerobic bacteria survive by extracting and consuming like nitrate and sulphates. Gases like ammonia, hydrogen sulphide, methane etc. are also evolved in this decomposition, producing obnoxious (bad) odour.

Odour:

- The odour of a fresh sewage is not offensive or practically it can be considered odourless, but as it starts to get stale, it begins to give offensive odour. Within 3 to 4 hours, all oxygen present in the sewage gets exhausted and it starts emitting offensive odour by hydrogen sulphide gas which is formed due to anaerobic decomposition of sewage.

Physical Characteristics

The temperature has an effect on the biological activity of bacteria present in the sewage and it also affects the solubility of gases in sewage. It also affects the viscosity of sewage (more is the temperature, lesser is the viscosity of sewage).

- The normal temperature, of sewage is slightly higher than the temperature of the water supply because of the additional heat due to utilization of water. Also when the wastewater flows in a closed pipes, its temperature future increases.
- The average temperature of sewage in India is about 20 °C which is near about ideal temperature of sewage for biological activities. At higher temperature coupled with the lower dissolved oxygen activities can cause serious problems in disposal of wastewater.

UNIT II

WATER TREATMENT AND DISTRIBUTION

INTRODUCTION

- The disposal of sewage effluent is the last stage of getting rid of sewage after subjecting it to various steps of processes (i.e.) treatment of transforming the sewage into the harmless liquid which fulfils the minimum standard of health and sanitation.
- The main object of controlling disposal of sewage are
- To render the sewage inoffensive
- To save the aquatic life in streams

- To eliminate the danger of contamination of water supplies.
- The amount or degree of treatment that should be given to the sewage depends upon the source of its disposal as well as its capacity to assimilate the impurities present in the sewage without itself getting polluted or less useful.
- So before designing the treatment plant first the source of disposal has to be selected.

Natural Methods

- Dilution or disposal into water i.e. into sea, lakes or rivers
- Disposal on land or land treatment i.e. sewage farming and irrigation.

Artificial Methods

- Artificial method is by which the sewage is disposed off only after subjecting it to various treatments (primary and secondary) such as:
- Screening and detritus removal
- Sedimentation with or without chemicals
- Biological treatment (trickling filter, oxidation pond or activated sludge process)
- Now a days the actual practice is to use both the methods, the sewage is first given the treatment and then it is disposed off by any of the natural method. If full treatment is not given at least the primary treatment is given before disposal.

Dilution

- Dilution is a prominent method of natural disposal, consists of discharging the wastewater into receiving water body (Such as river, sea, lake etc.)
- This is done on the assumption that the sufficient dissolved oxygen is available in the water body so that biochemical oxygen demand is satisfied.

- If however, the diluting water is not sufficient to supply the biological(or biochemical) oxygen demand to oxidise the entire matter present, there will be nuisance of foul odour and unsightly islands of half digested floating, putrefying matter at the surface.
- In addition to this problem, the depletion of oxygen would kill the aquatic life, and if this dilution water is used at the downstream side for drinking purpose, it will cause danger to the public health

- The discharged wastewater or effluent is purified, in due course of time, by the so called self purification process of natural streams.
- The limit of effluent discharge and the degree of treatment of wastewater depend upon the self purification capacity of natural waters as well as the intended use of the water body at the downstream side.

Conditions Favoring Disposal

- The Dilution method for disposing of the sewage can be favorable by adopted under the following conditions:
- When the sewage is comparatively fresh i.e. it is discharged within 3-4 hours of its collection.
- When the floating matter and settleable solids have been removed by primary treatment.
- When the diluting water has high DO content, so that not only the BOD is satisfied, but sufficient DO remains available for the aquatic life.

- Where the dilution waters are not used for the purpose of navigation or water supply for at-least some reasonable distance on the downstream from the point of sewage disposal.
- Where flow current of the diluting waters are favorable, causing no deposition or destruction to aquatic life. Its means that swift forward currents are helpful, as they easily carry away the sewage to the point of unlimited dilution. On the other hand, slow back currents tend to cause sedimentation, resulting in large sludge deposits.
- Where the wastewater does not contain industrial wastewater having toxic substances.
- When the outfall sewer of the city or the treatment plant is situated near some natural waters

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TYPES OF RECEIVING WATERS FOR DILUTION

- The following are the types of receiving waters into which wastewater or effluent can be discharged for dilution:
- Perennial rivers and streams
- Lakes
- Oceans or Sea
- Estuaries
- Creeks

Types Of Receiving Waters For Dilution



PERENNIAL RIVERS AND STREAMS

- Perennial rivers or streams are probably the best type of receiving waters, since the water is in continuous motion.
- Also in the natural streams there is balance between plant and animal life, with considerable interaction among the various life forms.
- However the discharge flowing during summer and during winter varies.
- During summer, there may be minimum flow in the stream, so the dilution factor may be low, and also high temperature of water may result in low solubility of oxygen, necessitating proper treatment before dilution

UNIT III

SEWAGE TREATMENT DISPOSAL

SEWER:

Liquid

It is the pipe or conduit for carrying sewage. It is generally closed and flow takes place under gravity (Atmospheric Pressure).

SEWERAG

Sewerage is the system of collection of waste water and conveying it to a point of final disposal with or without treatment

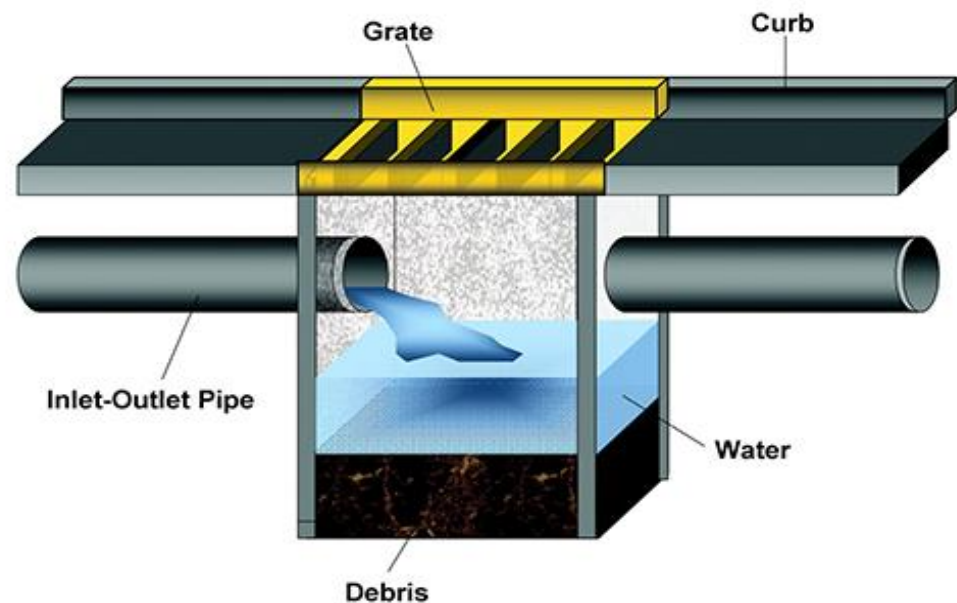
DESIGN OF SEWERS

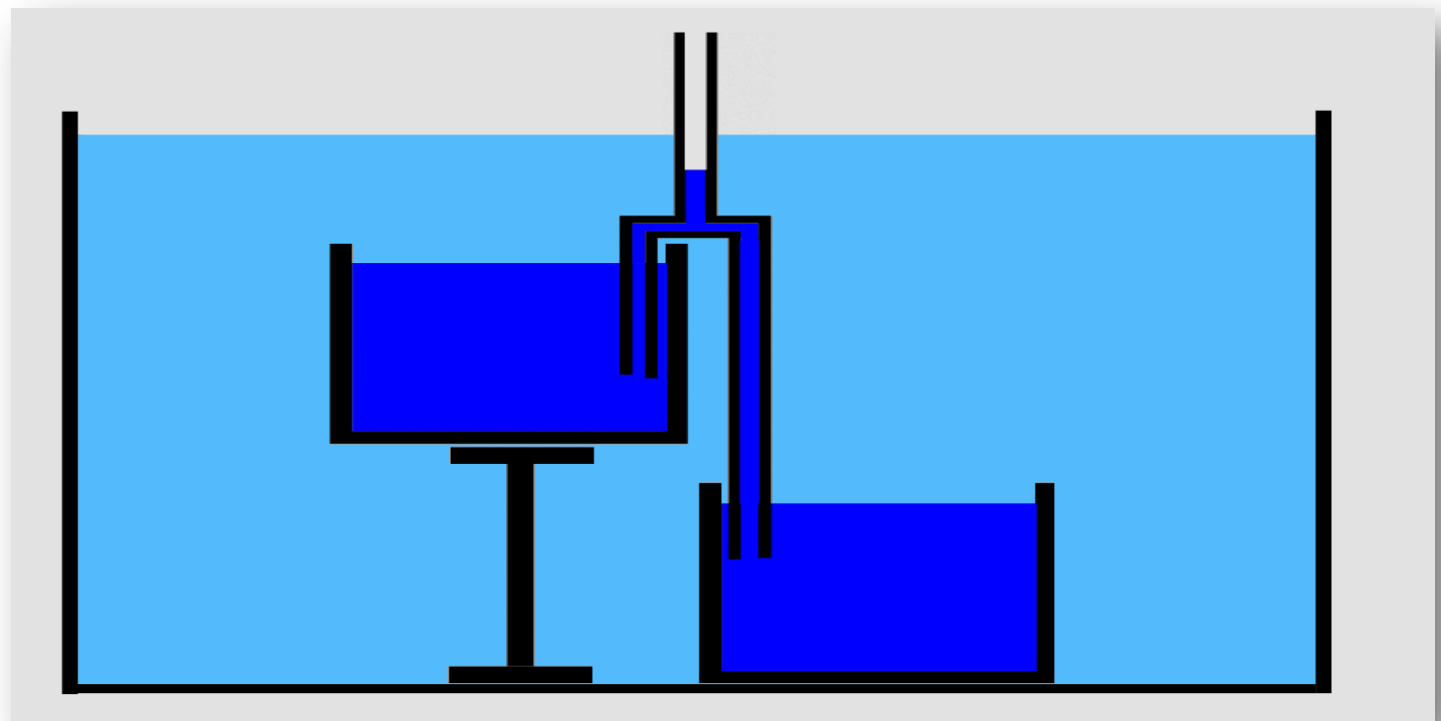
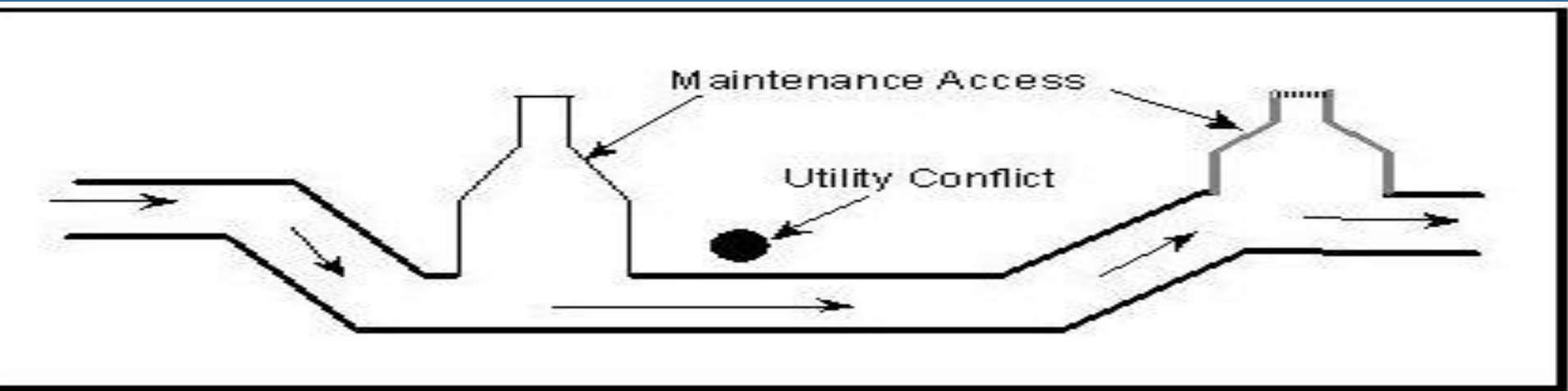
- Sewer system plays a vital role in the economic development of a country. Sewers are must for the drainage of waste water.
- In order to have an effective sewage system the sewers should be properly designed and more care should be taken in finding the Inver
- Sewers are designed for the drainage of waste water coming from houses, industries, streets, runoff etc to protect the environment and people from serious diseases, as more than 50 diseases spread from sewage.
- t levels otherwise whole design may get wrong



Sewer Appurtenances:

- Sewer appurtenances are the various accessories on the sewerage system and are necessary for the efficient operation of the system.
- They include man holes, lamp holes, street inlets, catch basins, inverted siphons, and so on





Factors considered for construction of sewers

- Intended use- Type of waste water.
- Installation requirements – Pipe characteristics and sensitivities.
- Corrosion conditions- chemical, Biological.
- Flow requirements –Pipe size, Velocity, Slope.
- Cost effectiveness- Materials, installation, maintenance.
- Handling requirements-Weight, impact resistance

Following are different types of sewers according material



- Asbestos Cement (AC) Sewer
- Brick Sewer
- Cement Sewer
- Cast iron (CT) Sewer
- Steel Sewers

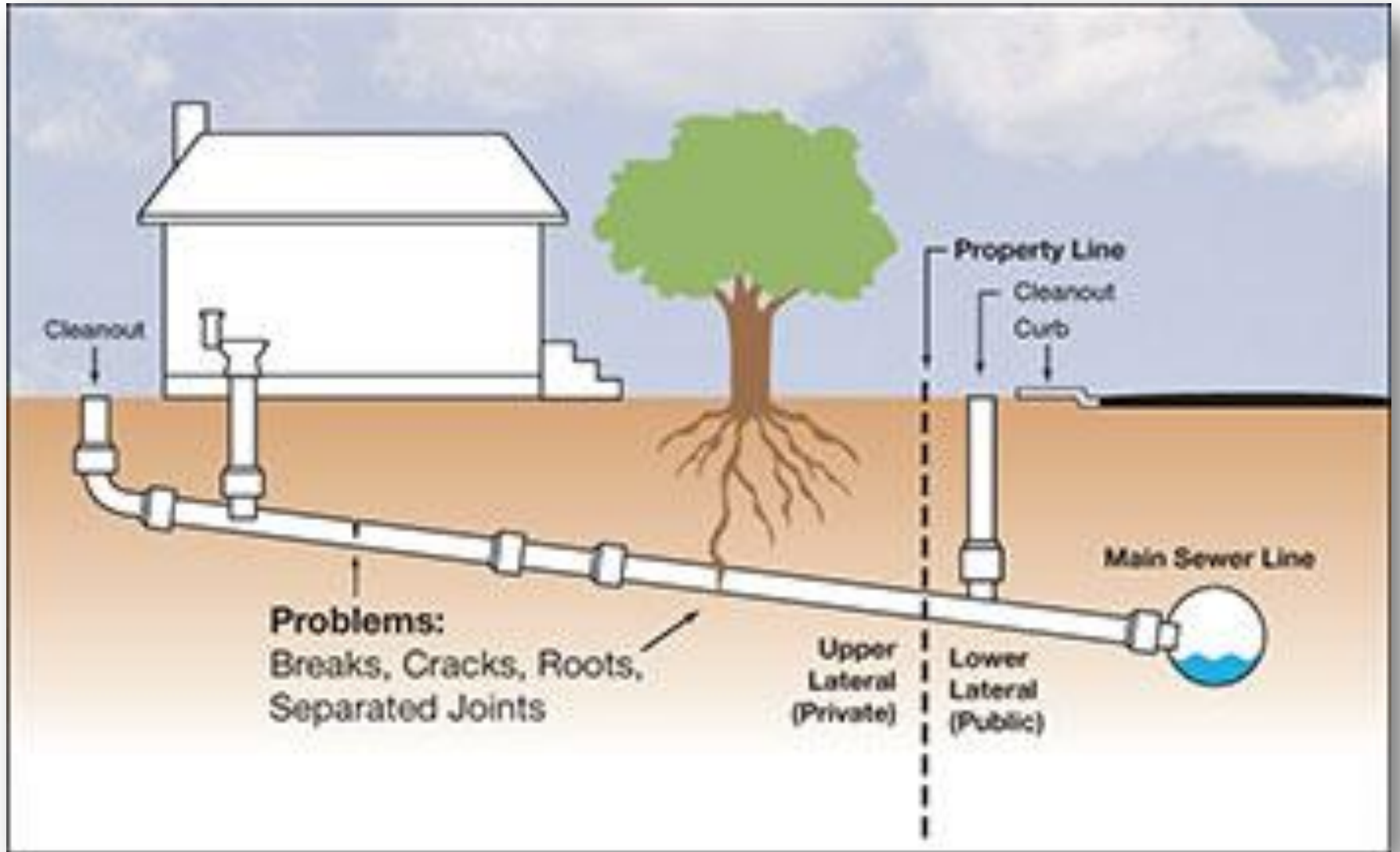
Sources of waste water

Following are the principal sources of waste water

- Domestic
- Industrial
- Storm water

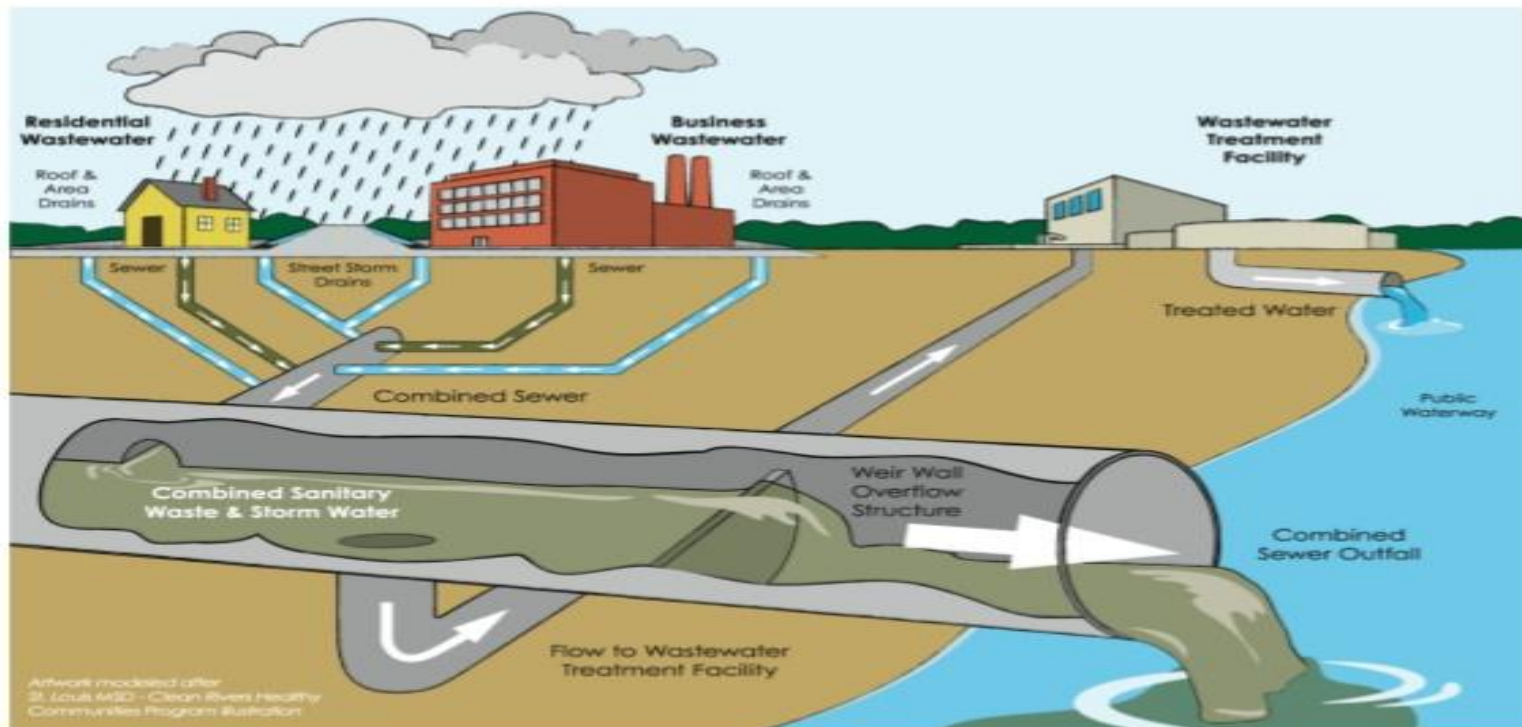
Domestic:

- It is the waste water from houses, offices, other buildings, hotels and institutions

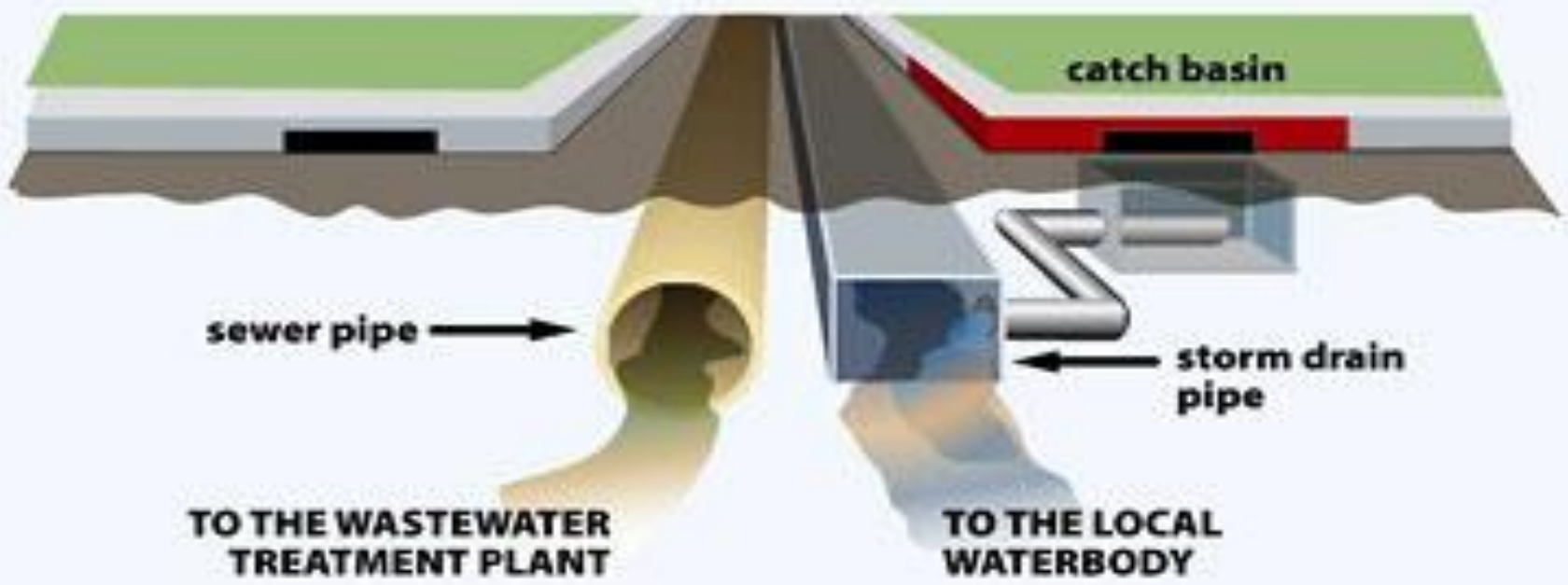


Industrial:

- It is the liquid waste from the industrial places from their different industrial processes like dyeing, paper matting, tanneries, chemical industries, etc



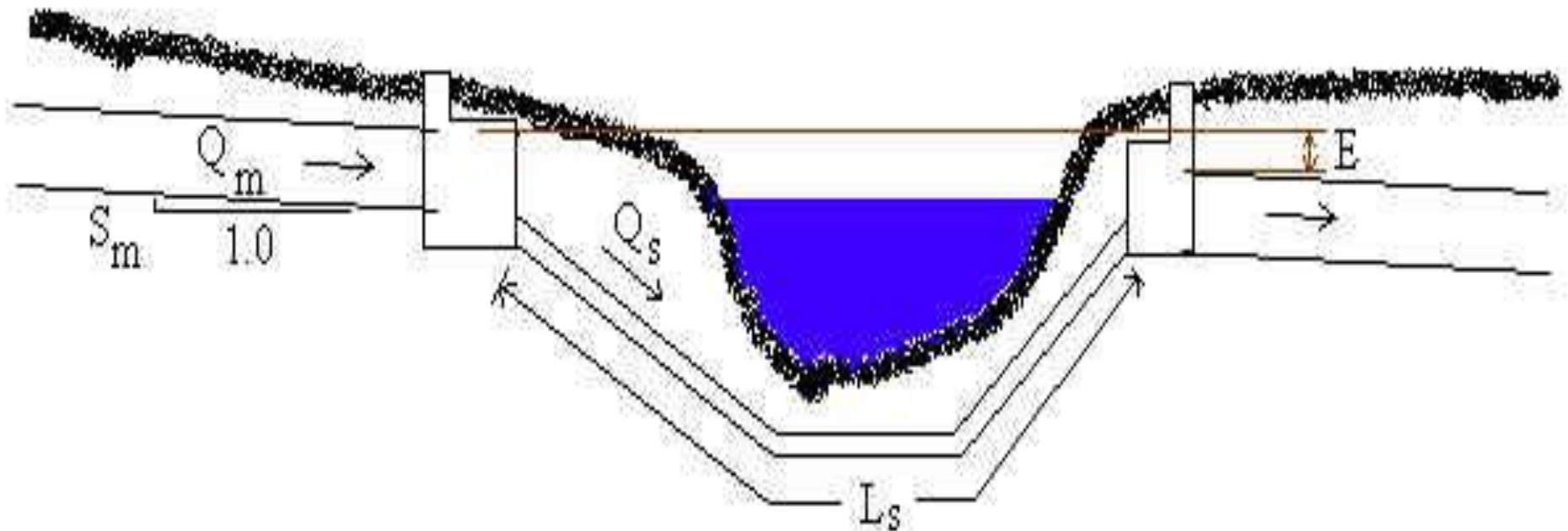
Storm Drain Systems are Separate from Wastewater Systems



- **Storm Water:**
- It includes surface runoff generated from rainfall and the street wash
- A **manhole** (alternatively **utility hole, cable chamber, maintenance hole, inspection chamber**) is the top opening to an underground utility vault used to house an access point for making connections, inspection, valve adjustments or performing maintenance on underground and buried public utility and other services including sewers, telephone, electricity, storm drains, district heating and gas.

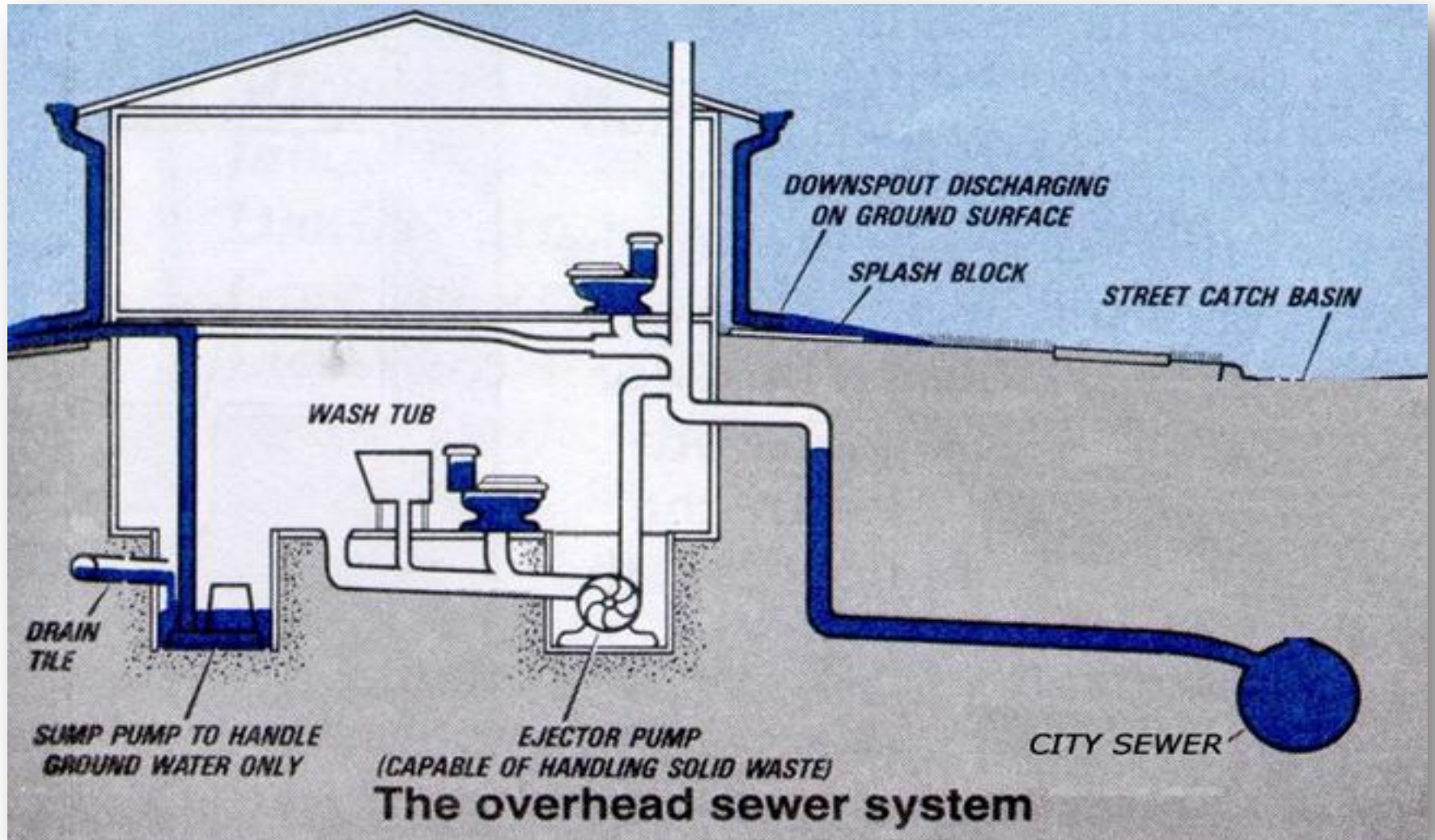
INVERTED SIPHON:

Inverted siphons (also called depressed sewers) allow storm water or wastewater sewers to pass under obstructions such as rivers



SEWER EJECTORS:

- A sewage ejector pump, also called pump up ejector system, is used when a bathroom, laundry room, or any other type of plumbing fixture is installed below the main sewer or septic line grade.
- Sewage ejector pumps are usually installed in basements. The ejector pump is part of a system that can pump both liquids and solids up into the main sewer or septic line



HOUSE DRAINAGE:

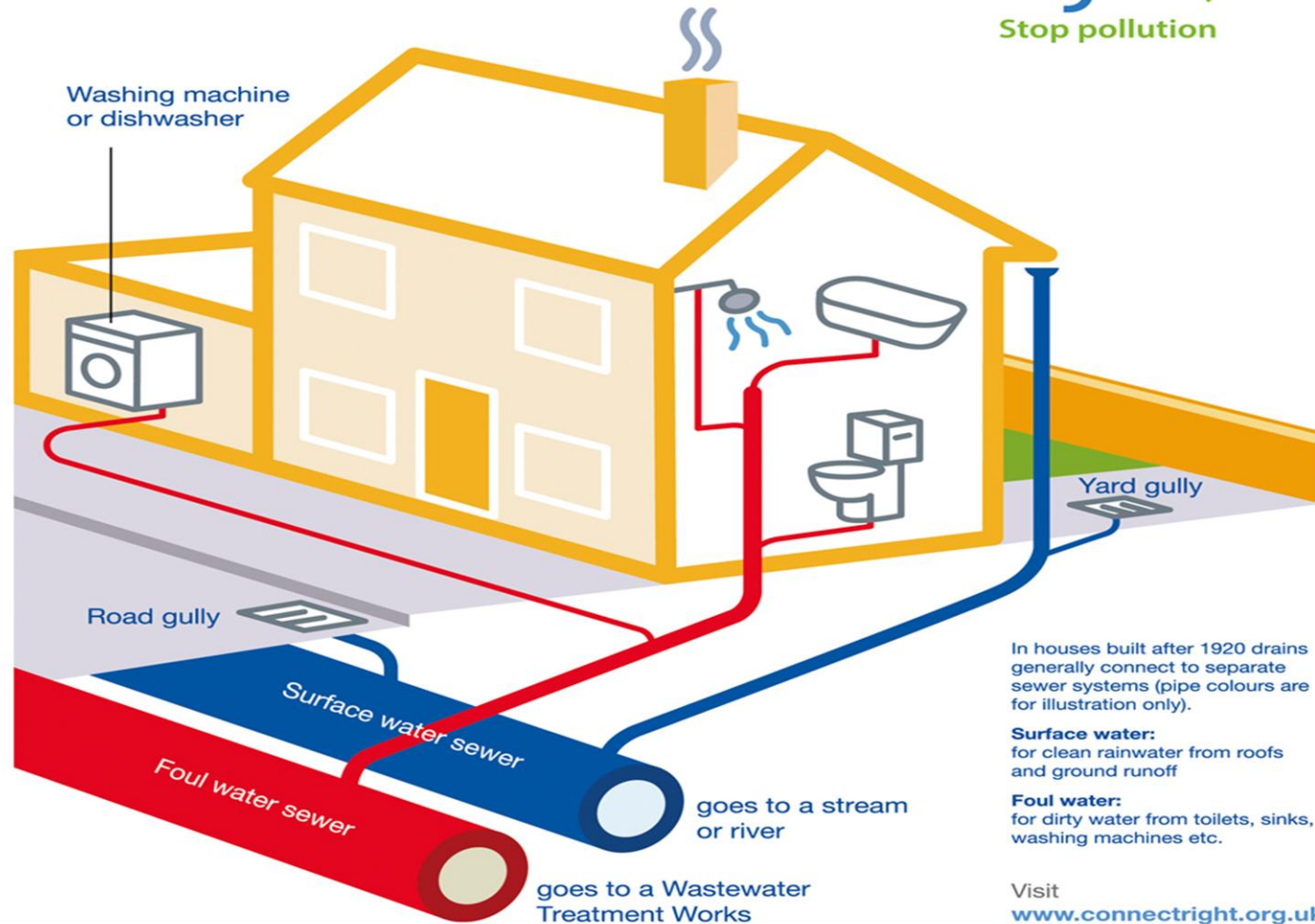
- A house drain is the system of horizontal piping inside of the cellar or basement of a building, that extends to and connects with the house sewer.
- It receives the discharge of sewage from all soil and waste lines, and sometimes rain water from rain, yard, cellar, area and sub-soil drains.

MATERIALS:

When buried in the earth, house drains should be constructed of cast-iron pipe coated with asphalt both inside and out

- In buildings over two stories in height they should be made of extra heavy cast-iron pipe in small cottages standard pipe may be used.
- It should be resistant to corrosion and abrasion caused by the sewage
- It can be easily cast or moulded into desired shapes and sizes.

connect
right ✓
Stop pollution



In houses built after 1920 drains generally connect to separate sewer systems (pipe colours are for illustration only).

Surface water:
for clean rainwater from roofs and ground runoff

Foul water:
for dirty water from toilets, sinks, washing machines etc.

Visit
www.connectright.org.uk

UNIT IV

WASTE WATER TREATMENT

Disposal of Wastewaters in Lake

- Water quality management is entirely different from that in rivers.
- River is a flowing water body while lake has stagnant waters, so in lakes only top surface would become saturated with DO, but the bottom layers would not have enough oxygen.
- Overturning of layers would not occur frequently, so that DO content would not be uniform through out the depth of lake.
- Overturning takes place only when there is change in the season due to which there will be temperature difference between water in different layers which cause change in the densities of different layers and overturning occurs.

LAKE POLLUTANTS

- In Lake the phosphorous a nutrient largely contained in industrial domestic wastewater is seriously affecting the quality of lakes and hence it is considered as the prime lake pollutant.
- Oxygen demanding wastes may be the other important lake pollutant.
- The toxic chemicals from industrial wastewater can be present

EUTROPHICATION

- Phosphorous acts as the nutrients for the algal growth.
- Increase in the phosphorous content would increase the algal growth.
- Excessive in the phosphorous content would increase the algal growth.
- Excessive algal growth (Algal Bloom) will create lot of the problems like taste, odour, problems in oxygen diffusion in lower layer.
- Ultimately the entire lake can get covered with algae and it may become useless for other organisms

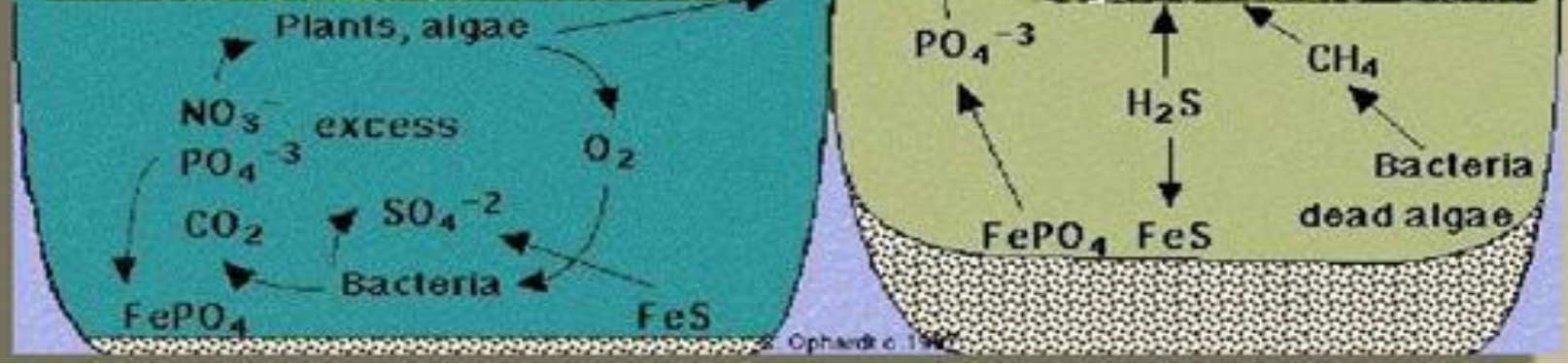
Eutrophication

Eutrophication

Aerobic - oxygen



Anaerobic - No oxygen



DISPOSAL OF WASTEWATER IN SEA OR OCEAN

- The saturation concentration of dissolved oxygen in water decreases with increasing salt concentration.
- DO in sea water is approximately 80 % of that in water.
- In addition to this deficiency, the temperature of sea water is lower than the sewage temperature, whereas the specific gravity is higher.
- Due to this deficiency, the temperature, whereas the specific gravity is higher.
- Due to this reasons, when the sewage is discharged into the sea water, the lighter and warmer sewage will rise up to the surface, resulting in spreading of the sewage at the top surface of sea in a thin film or 'sleek'

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- The sewage should be discharged in deep sea water.
- In order to mix sewage properly with the seawater, the sewage should be released at a minimum depth of 3 to 5 m below the water level and taking it sufficiently inside the shore, and thus preventing nuisance to baths and recreation centres on the shore.
- To prevent the backing up and spreading of sewage on the sea shore, the sewage should be disposed of only during low tides, large sized tanks may, therefore be constructed to hold the sewage during high tides. Provision of a large sized sewer, grated with non return valve at the end, is also an alternative to hold the sewage during high tides.

Before deciding the position of the outfall point, the sea current, wind directions, velocity, etc., should be properly studied. The sea currents, wind direction, velocity, etc.. should be properly studied. The point of disposal should be such that the sewage is taken away from the shore by the winds, and not brought back near the shore by the winds, and not brought back near the shore.

- The outfall sewer should be placed on a firm rocky foundation, and encased in thick stone masonry, so as to properly protect it from wave action, floating debris, etc..
- The discharge of Industrial waste waters into sea should however, be controlled in respect of the quality of the effluents, by adhering to the following Indian standards., prescribed by IS 1968-1976

- In this method, the sewage effluent either treated or raw is disposed of by applying it on land.
- The most common forms of land application are irrigation (Sewage farming) and rapid infiltration.
- When raw or partly treated sewage is applied on the land, a part of it evaporates and remaining portion percolates in the soil.
- If proper voids are maintained in the soil , the organic sewage solids are oxidized by the bacteria present in the soil under aerobic condition.

- However, if the soil is made of heavy, sticky, and fine grained materials, the void space will soon get clogged resulting in non aeration of these voids which would lead to anaerobic condition and subsequent evolution of foul gases.
- Application of too strong or too hard of sewage will also result in the quick formation of anaerobic conditions. The loads of sewage can be reduced by dilution or pretreatment.

Disposal of Sewage on Land



- The sewage effluents can be used for irrigating farms exactly in the same manner as irrigation water is used for farming.
- Wastewater can be applied to land by the following three methods.
- Sprinkler method or spray irrigation
- Subsurface irrigation
- Surface irrigation
- (a) Basin Method
- (b) Flooding method
- (c) Furrow method

- When the sewage is applied continuously on a piece of land, the soil pores or voids may get filled up and clogged with sewage matter retained in them.
- The time taken for such clogging will depend upon the type of the soil and the load present in sewage. But once these voids gets clogged, free circulation of air will be prevented an anaerobic conditions will develop within the pores.
- Decomposition of organic matter would take place under anaerobic conditions with evolution of foul gases like H₂S, CO₂ and methane.
- This phenomenon of soil getting clogged, is known as sewage sickness

Methods of Preventing Sewage Sickness



- In Order to prevent the sewage sickness of a land, the following preventive measures may be adopted.
 - Primary Treatment of Sewage: The Sewage should be disposed of, only after primary treatment, such as screening, grit removal, and sedimentation. This will help in removing settle able solids and reducing the BOD load by 30 % or so, and soil pore will not get clogged frequently.
- Choice of Land: The piece of land used for sewage disposal should normally be sandy or loamy. Clayey lands should be avoided.

Comparison of Disposal Methods

- For most of Indian towns and cities the land disposal is a better choice because of following reasons:
- India is a tropical country temperature remains high in most part of the year. Due to hot climate, DO content of the river water reduces, while the fish and aquatic life requires higher DO for their survival, thus making the dilution method more difficult and prohibitive.
- Most of the rivers have a very small amount of dry weather flow (in summer) so amount of dilution available would be less. Also in most of the cities these rivers are the only source of drinking water. So disposal by dilution method cannot be used, and if used, a very high degree of treatment is required which would increase the cost of disposal.

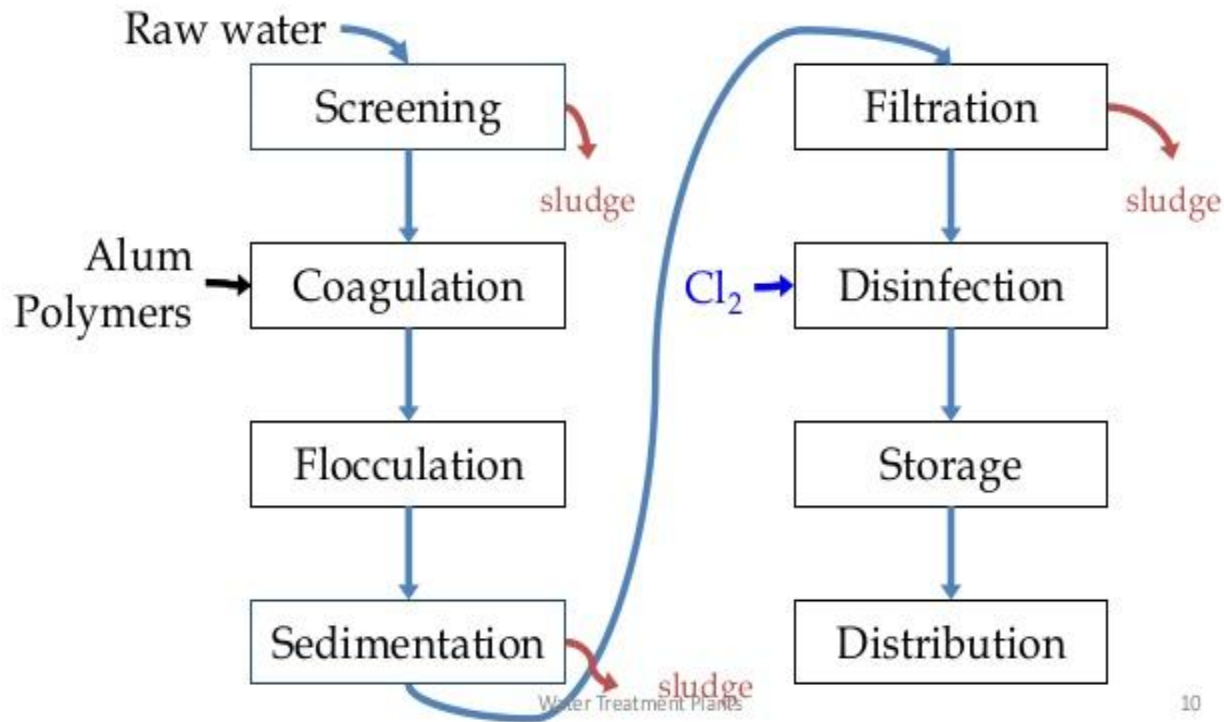
- Except for a few major cities, the water supplies in India are very low, thus resulting in the production of highly concentrated sewage, which on travelling in hot climate, becomes stale and septic by the time it reaches the disposal point, thus prohibiting the use of dilution method for disposal.
- There are only a few coastal towns in India, which have strong tidal currents moving in the forward directions, and the necessary depth of water at the point of disposal, thus prohibiting the disposal of sewage in the sea on large scale.

UNIT V

DESIGN AND WORKING OF TREATMENT UNITS

LAYOUT OF WATER TREATMENT

Conventional Surface Water Treatment



PRINCIPLES OF WATER TREATMENT



The Principles of Water and Wastewater Treatment Processes has been divided into the following Units:

- Water Quality
- Physical Processes:

Microbes and other colloidal particles can be physically removed from water by various processes. The sizes of the microbes are especially important for their removal by sedimentation and filtration.

PRINCIPLES OF WATER TREATMENT

- Chemical Processes:

Calcium hydroxide (hydrated lime) ($\text{Ca}(\text{OH})_2$): Is dosed at the start and end of the treatment process.

The pre-dose increases the alkalinity for optimal coagulation as well as the hardness and buffering capacity of water (resistance to change in pH).

The post-dose is to raise the pH to within drinking water guidelines and the optimum level for the residual disinfectant.

- Sludge Treatment:

Sludge is produced from the treatment of wastewater in on-site (e.g. septic tank) and off-site (e.g. activated sludge) systems. The primary aim of wastewater treatment is removing solids from the wastewater.

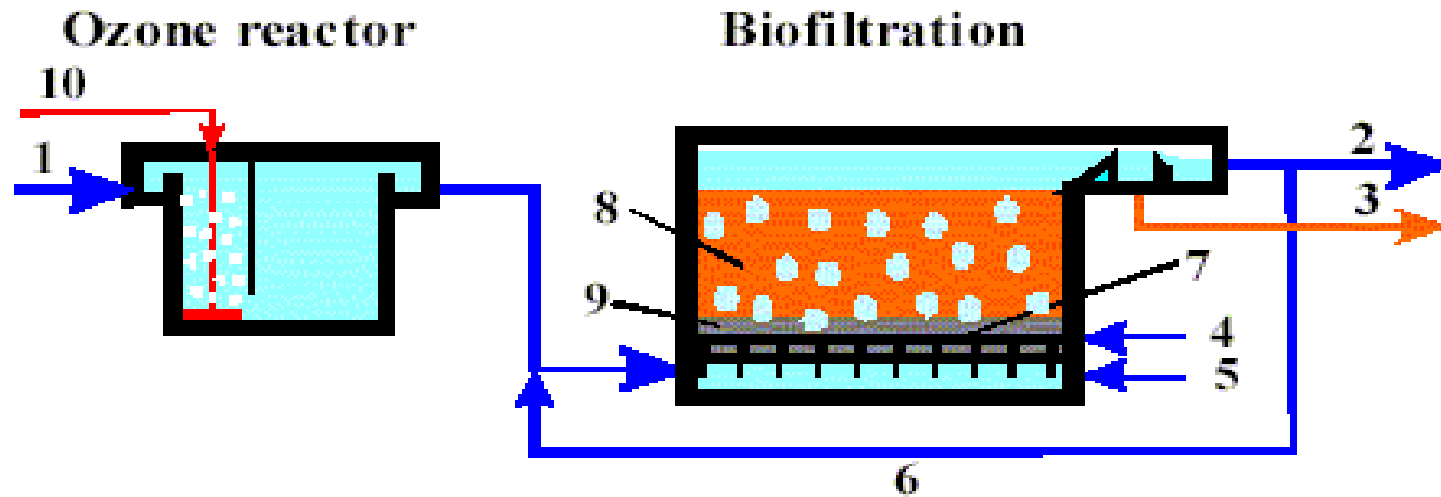
- Odour Management:

Wastewater treatment plant odors are common. Perimeter odour neutralizing spray systems can be used to great effect to control **wastewater treatment plant odors.**

(Bio filtration systems can treat several contaminants simultaneously, without the use of chemicals. With 95% odor removal efficiency, our bio filtration systems can treat a wide range of contaminants.)

Biofiltration

Biofiltration is a means of removing odorous and non-odorous gases from waste air-streams utilising multi-strain micro-organisms to biologically degrade volatile organic compounds (VOC's) to simpler forms i.e. CO₂ and water. Multi-strain micro-organisms can even degrade landfill gas and petrol vapour to simple non-polluting forms.



- 1 Water to be treated
- 2 Treated water
- 3 Back wash water
- 4 Process air
- 5 Flushing air

- 6 Wash water
- 7 Air distribution system
- 8 Filter medium
- 9 Supporting medium
- 10 Ozone gas

SURFACE LOADING

Calculating the surface loading gives a guide to how much water can be processed each day per area of sedimentation tank.

- Surface loading is one of the most important factors affecting the effectiveness of the sedimentation process. The surface loading rate is used to determine if the sedimentation tanks and clarifiers are under loaded or over loaded.
- If actual surface loading is $>$ the design values then this indicates the tanks are overloaded.
If actual surface loading is $<$ the design values then this indicates the tanks are underloaded.

AERATION:

- Aeration (also called aerification) is the process by which air is circulated through, mixed with or dissolved in a liquid or substance.
- Passing the liquid through air by means of fountains, cascades, paddle-wheels or cones.

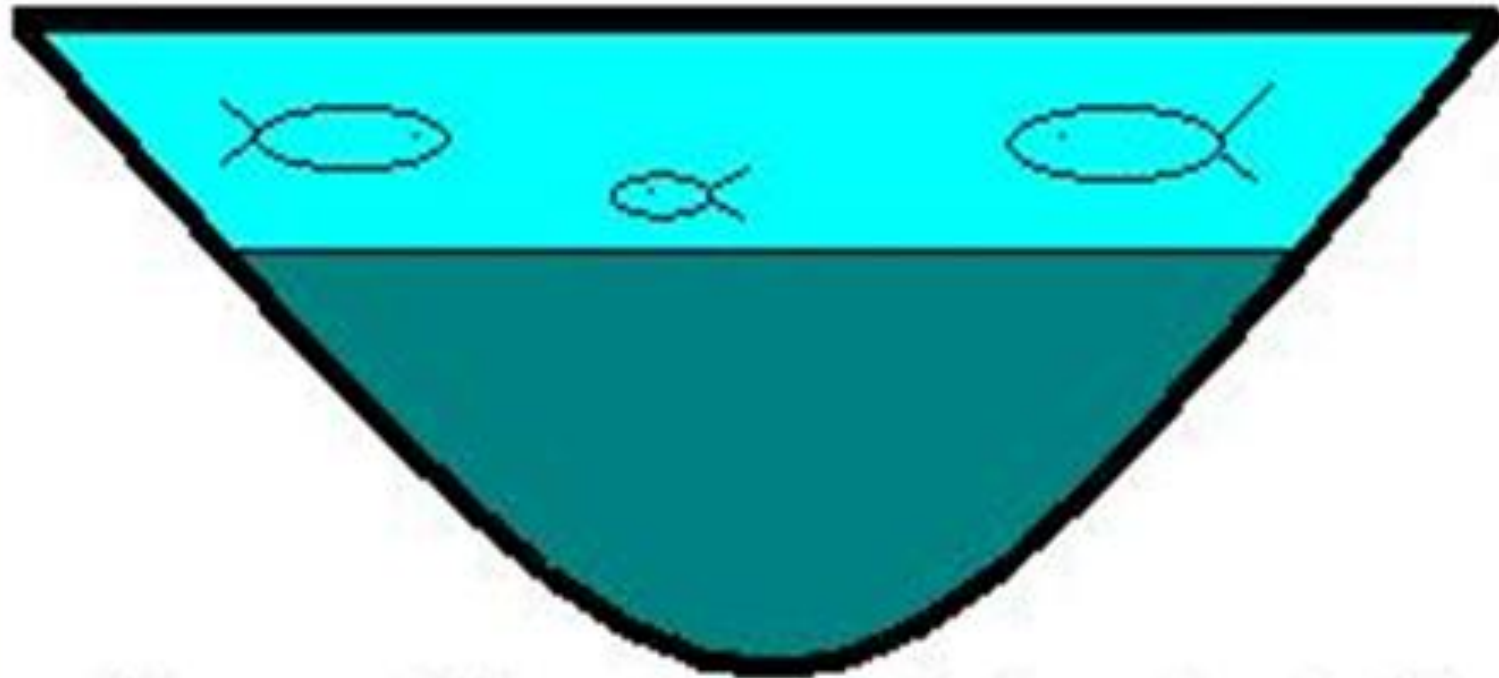


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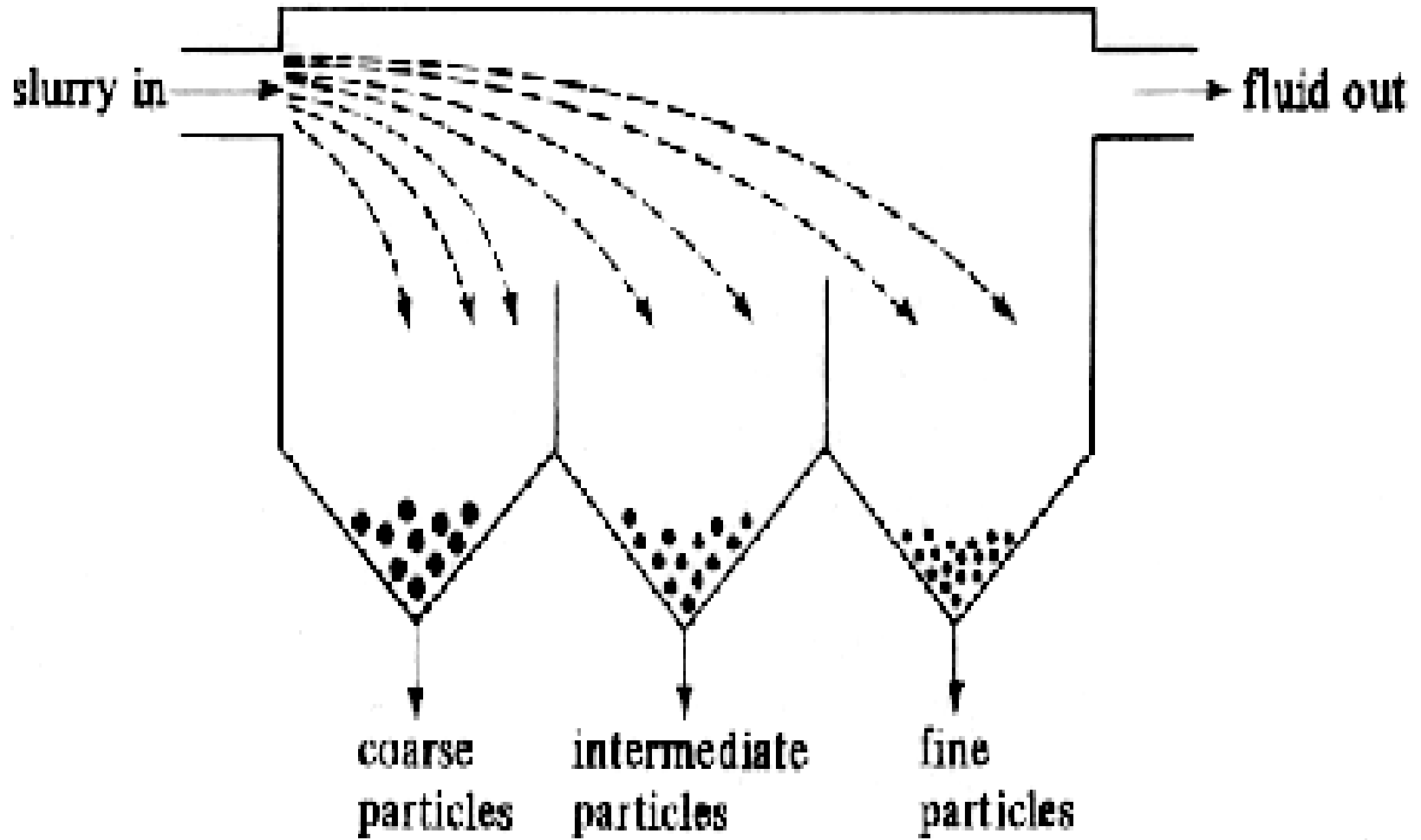
Without Aeration



Decreased Oxygen Levels in lower levels of pond.

THINGS THAT MATTER FOR SETTLING PROCESS?

- Size, shape and specific gravity of the particles.
- ***Discrete particle settling*** - Particles settle individually without interaction with neighboring particles.
- ***Flocculent Particles*** – Flocculation causes the particles to increase in mass and settle at a faster rate.
- ***Hindered or Zone settling*** –The mass of particles tends to settle as a unit with individual particles remaining in fixed positions with respect to each other.
The purpose of a Water Treatment Plant is to remove particulates and pathogens from water that may pose a health threat to consumers



PRINCIPLES OF WATER TREATMENT



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- Odour Management:

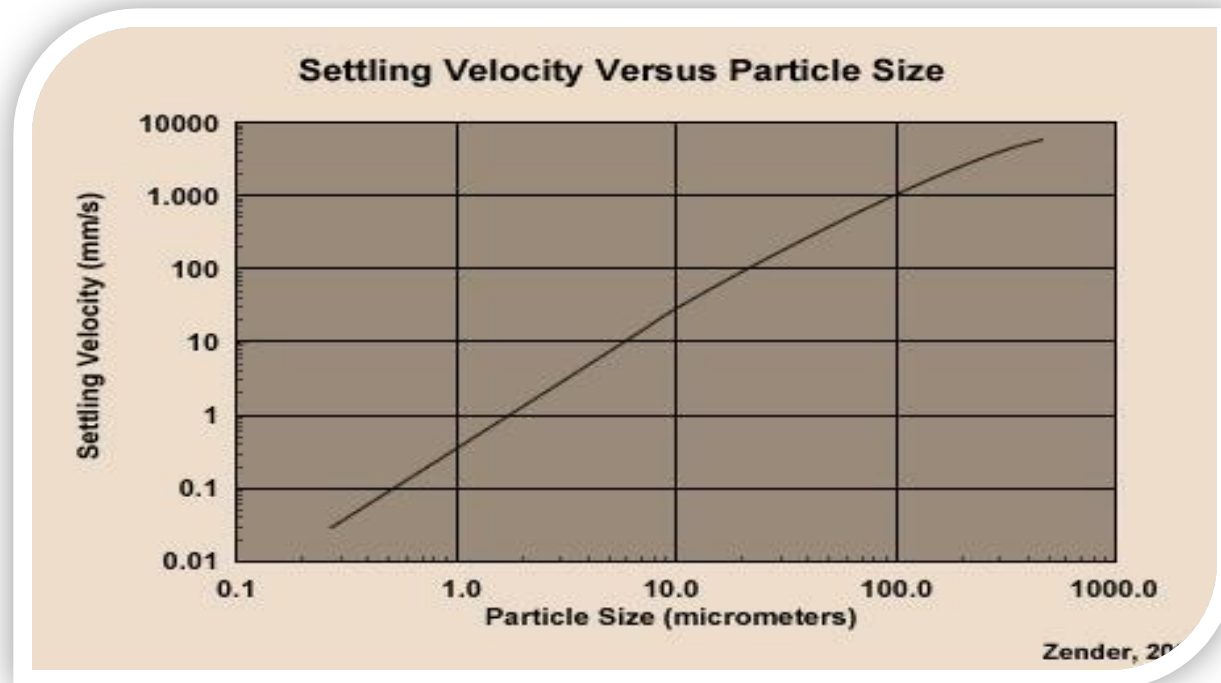
Wastewater treatment plant odours are common. Perimeter odour neutralising spray systems can be used to great effect to control wastewater treatment plant odours.

(Biofiltration systems can treat several contaminants simultaneously, without the use of chemicals. With 95% odour removal efficiency.)

- Aeration (also called aerification) is the process by which air is circulated through, mixed with or dissolved in a liquid or substance.
- Passing the liquid through air by means of fountains, cascades, paddle-wheels or cones.

UNIFORM SETTLING VELOCITY:

- Settling is the process by which particulates settle to the bottom of a liquid and form a sediment.
- Particles that experience a force, either due to gravity or due to centrifugal motion will tend to move in a uniform manner in the direction exerted by that force



OXIDATION POND

Pond that contains partially treated wastewater which is then left to allow the growth of algae and bacteria which decompose of the waste.

Oxidation Ponds are also known as stabilization ponds or lagoons.

The production of these supports the growth of algae in the oxidation pond.

Within an oxidation pond heterotrophic bacteria degrade organic matter in the sewage which results in production of cellular material and minerals.

Uses:

- Production of aerated water for drinking purposes.
- Secondary treatment of sewage or industrial wastewater through use of aerating mixers/diffusers.
- To increase the oxygen content of water used to house animals, such as aquarium fish or fish farm.
- In chemistry, to oxidize a compound dissolved or suspended in water.

Maintenance of oxidation ponds

The operation and maintenance of the oxidation ponds are very simple and do not require skilled person.

Chemicals are not commonly used to prevent mosquito nuisance, because the chemicals may adversely affect the algae growth and treatment of sewage.

The quantity of sludge collected in these ponds is small.

For 120cm deep pond, sludge removal may be required about 6yrs.

In every 12 yrs, in case of over load sodium nitrate should be added to increase algae growth rate



Thank you