SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – I – SOLID WASTE MANAGEMENT – SCIA4002

INTRODUCTION

IMPORTANCE OF PUBLIC HEALTH ENGINEERING:

- ✓ Environmental engineers design municipal water supply system and provide safe drinking water or secure water supplies for potable and agricultural use.
- ✓ To achieve these, they examine the watersheds with a hydrological or geological point of view as well as engineering treatment systems for water purification.
- ✓ Various water treatment methods are used, including membrane technology, desalinization, biological water treatment, etc. Water distribution systems are also designed and built.
- ✓ Environmental engineers also develop collection and treatment systems to carry domestic or industrial waste water discharges away and remove some of the pollutants before discharging it into the environment.

ROLE OF PUBLIC HEALTH ENGINEER:

- ✓ Public health engineers apply engineering principles in order to detect, control, evaluate and manage environmental factors that impact public health.
- ✓ They may investigate public water supplies, sewage systems, public swimming pools and hospitality businesses regarding water quality controls.
- ✓ They also may inspect restaurant establishments to verify food and general sanitation.
- ✓ They also visit industrial companies to check on air and water pollution controls as well as manufacturing practices.
- ✓ Public health engineers need to maintain a good knowledge of the principles and practices of public health engineering and environmental health.
- ✓ Some specialize in certain areas, such as radiology, air pollution, water purification and sewage disposal.
- ✓ Those who work in the office may gather and interpret the results of lab results regarding sewage, water samples and industrial wastes.
- ✓ During disease outbreaks, they work with epidemiologists and other public health officials to investigate the contributing environmental health factors.
- ✓ Public health engineers should be confident working in the field under a variety of social, weather and environmental conditions.

➢ **The job involves numerous things including:**

- ✓ Address the public or lawmakers about health concerns or regulations
- ✓ Assist problem facilities or private industries in improving their safety levels
- ✓ Inspect and analyze public health facilities and systems
- ✓ Develop plans for improving facilities and health programs

- ✓ Educate public about health concepts and safety measures
- ✓ Review data and lab reports
- ✓ Consult with various agencies to enhance safety.

SOURCES OF SOLID WASTES:

- ➢ Residential Wastes
- ➢ Commercial Wastes
- ➢ Institutional Wastes
- ➢ Municipal solid Wastes
- ➢ Industrial Solid Wastes
- ➢ Mining solid Wastes
- ➢ Agriculture Wastes
- ➢ Excretory products of humans and livestock Wastes
- ➢ Electronic wastes
- ➢ Hospital or Biomedical Wastes
- ➢ Construction and demolition Wastes
- ➢ Hazardous waste.

MUNICIPAL SOLID WASTES:

- ✓ These are solid wastes from home, offices, stores, schools, hospitals, hotels etc.
- ✓ These domestic solid wastes one usually, thrown in municipal garbage collecting cans or on road side open waste lands.
- ✓ They are collected by municipality vehicles to certain garbage disposal site.
- ✓ They are dumped over a large area of land which becomes the breeding ground of flies and rats.
- ✓ Usually, they are not burnt to reduce the volume because burning would cause air pollution which is still more dangerous.

Figure No.1

INDUSTRIAL SOLID WASTES:

- ✓ Most of the toxic industrial wastes are dumped on waste lands for slow and gradual decomposition.
- ✓ Some industries dump their effluents on barren land, road sides creating very unhygienic environment for the local population.
- ✓ Some of the effluents have heavy metals which pollute the ground water through seepage during the monsoon season.
- ✓ Some heavy metals have been found slowly accumulating on farmland soils.
- ✓ One such most toxic heavy metal is cadmium which is present in traces in some fertilizers.

Figure No.2

MINING SOLID WASTES:

- ✓ They include mine dust, rock tailing, slack and slag. Open cast mining completely spoils the surrounding soil.
- ✓ Toxic chemicals and metals present in the mining wastes destroy vegetation and produce many deformities in animals and human beings.

Figure No.3

AGRICULTURAL WASTES:

- ✓ Chemical fertilizers increase soil fertility and gives better crop yield in lesser time.
- ✓ Shortly, the land becomes saline, acidic or alkaline and loses fertility.
- ✓ These toxic chemicals used in crop field which are not ecofriendly.
- ✓ They enter into crop and then into primary and secondary consumers.
- ✓ Even human beings are affected due to bio-magnification.

Figure No.4

EXCRETORY PRODUCTS OF HUMANS AND LIVESTOCK:

- ✓ In underdeveloped and developing countries, the poor sanitary conditions aggravate soil pollution.
- ✓ The excreta of man and animals, digested sewage sludge used as manure pollute the soil.
- ✓ Several germs present in such wastes contaminate soil, vegetables, and water bodies causing severe health hazards.

ELECTRONIC WASTES:

- ✓ The latest solid waste that has appeared in last twenty years commonly known as e-wastes is no less harmful.
- ✓ Irreparable computer and electronic goods.
- ✓ Frequently, more efficient and user-friendly electronic items appear in the market thus discarding the old generation equipment which simply become garbage or solid wastes.
- ✓ Over half of the e-wastes generated in developed countries are exported to developing countries where they ultimately increase the e-garbage proportions.

Figure No.5

HOSPITAL OR BIOMEDICAL WASTES:

- ✓ Biomedical waste or hospital waste is any kind of waste containing infectious (or potentially infectious) materials.
- ✓ Hospitals generate hazardous wastes that contain disinfectants, other harmful chemicals and pathogenic microorganism.
- ✓ Such wastes require careful treatment and disposal.

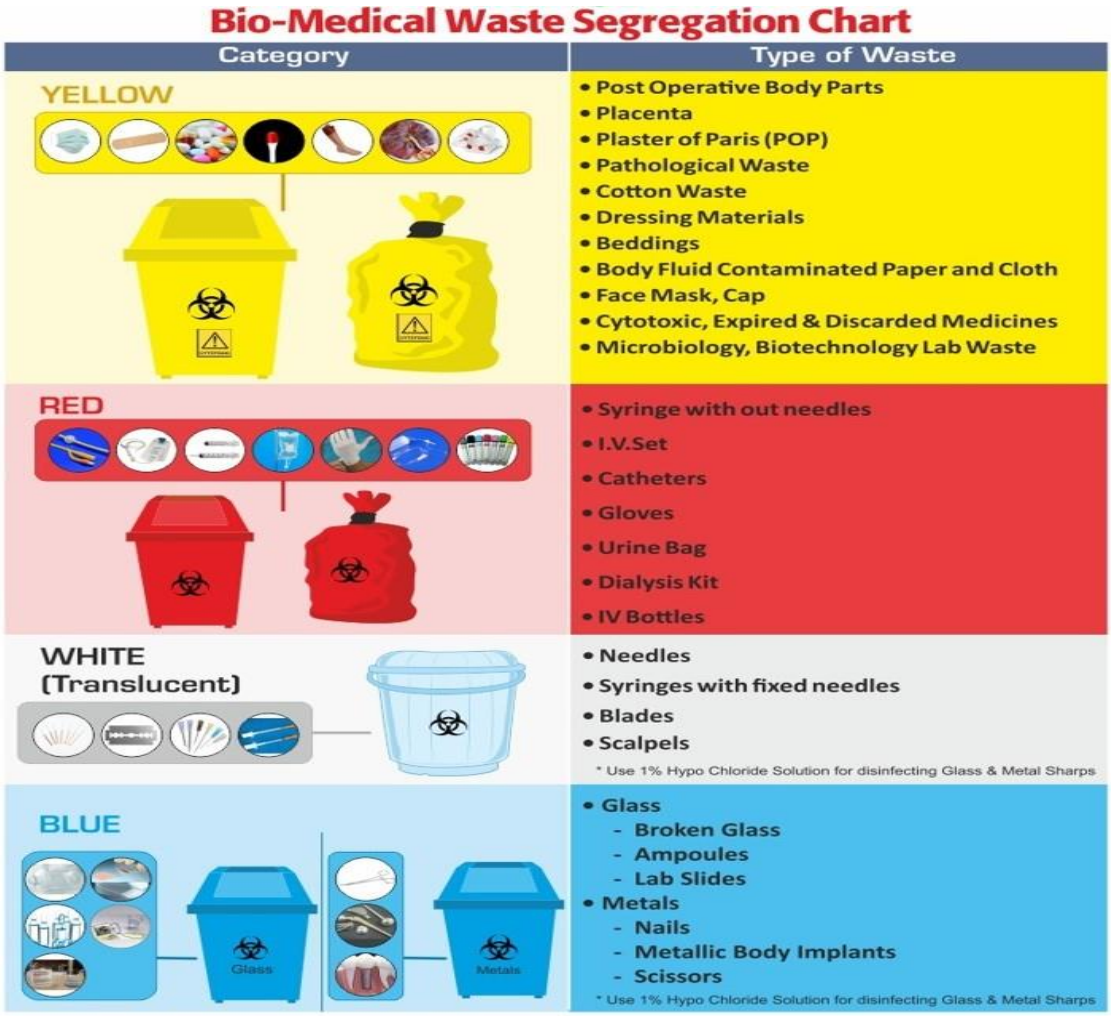


Figure No.6

CONSTRUCTION AND DEMOLITION WASTES:

- ✓ As per the Construction and Demolition (C&D) Waste Rule 2016, 'any waste comprising building materials, debris and rubble resulting from construction, remodeling, repair and demolition of any civil structure' is classified as C&D waste.
- ✓ Characteristics of the waste C&D waste is an inert waste, over 90 per cent of which can be easily reused or recycled.
- ✓ A study by Technology Information, Forecasting and Assessment Council (TIFAC) in 2001 noted that C&D waste in India typically contains soil, sand and gravel (36 per cent), bricks and masonry (31 per cent), concretes (23 per cent), metal (5 per cent), wood (2 per cent), and others (3 per cent).
- ✓ Construction and demolition waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, fly over, subway, remodeling etc.
- ✓ It consists mostly of inert and non-biodegradable material such as concrete, metal, wood, plastics etc.

- **MAJOR COMPONENTS**

✓ Cement concrete

✓ Bricks

✓ Cement plaster

✓ Steel (from RCC, door/window frames, roofing support, railings of staircase etc.)

✓ Stone (marble, granite, sand stone)

✓ Timber/wood (especially demolition of old buildings)

- **MINOR COMPONENTS**

✓ Conduits (iron, plastic)

✓ Pipes (GI, iron, plastic)

✓ Electrical fixtures (copper/aluminium wiring, wooden baton/plastic switches, wire insulation)

✓ Panels (wooden, laminated) & Others (glazed tiles)

Figure No.7

HAZARDOUS WASTE:

✓ Industrial and hospital waste is considered hazardous as they may contain toxic substances.

✓ Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g., gases**.**

✓ India generates around 7 million tons of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu.

- ✓ Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.
- ✓ Hospital waste contaminated by chemicals used in hospitals is considered hazardous.
- ✓ These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure.
- ✓ Most hospitals in India do not have proper disposal facilities for these hazardous wastes.
- ✓ In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.
- ✓ Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal.

Figure No.8

TYPES OF SOLID WASTES:

- ➢ Garbage
- ➢ Ashes and Residues
- ➢ Combustible and Non-combustible Wastes
- ➢ Bulky Wastes
- ➢ Street Wastes
- ➢ Biodegradable and Non-biodegradable Wastes

- Dead animals
- Abandoned vehicles

GARBAGE:

- ✓ It is unwanted materials and objects that people have thrown away. It is often also called trash, garbage, rubbish, or junk.
- ✓ Garbage is the waste we produce daily in our homes, including old or unwanted food, chemical substances, paper, broken furniture, used containers, and other things.

ASHES AND RESIDUES:

- ✓ These are substances remaining from the burning of wood, coal, charcoal, coke and other combustible materials for cooking and heating in houses, institutions and small industrial establishments.
- ✓ Ashes consists of fine powdery residue, cinders and clinker often mixed with small pieces of metal and glass.
- ✓ Since ashes and residues are almost entirely inorganic, they are valuable in landfills.

COMBUSTIBLE AND NON-COMBUSTIBLE WASTES:

- ✓ These consists of wastes generated from households, institutions, commercial activities etc. excluding food wastes and other highly putrescible material.
- ✓ Combustible: paper, cardboard, textile, barrels, rubber, wood, excelsior, tree branches, yard trimmings, wood furniture.
- ✓ Non- combustible: metals, tin cans, metal furniture, dirt, glass, crockery, minerals. Source: Same as garbage.

BULKY WASTES:

- ✓ Bulky waste items include discarded furniture (couches, recliners, tables), large appliances (refrigerators, ovens, TVs), and plumbing fixtures (bathtubs, toilets, sinks).
- ✓ A large amount (30-60%, depending on area) of bulky waste is picked up by scavengers before it is collected.

STREET WASTES:

- ✓ These include dust blown from unpaved areas, sometimes from within the city and sometimes from a great distance, and decaying vegetation such as fallen leaves, blossoms and seeds which originate from trees and plants in the city.

BIODEGRADABLE AND NON-BIODEGRADABLE WASTES:

- ✓ A biodegradable substance can be defined as a material which can be decomposed by microorganisms or decomposers and not be adding to any type of pollution.

- ✓ Waste that cannot be decomposed by the biological ways is called the Non-biodegradable wastes.
- ✓ Biodegradable waste can be found in municipal solid waste (sometimes called biodegradable municipal waste, or as green waste, food waste, paper waste and biodegradable plastics).
- ✓ Other biodegradable wastes include human waste, manure, sewage, sewage sludge and slaughterhouse waste.
- ✓ Non-biodegradable wastes are those who cannot be decomposed or dissolved by natural agents.
- ✓ They remain on earth for thousands of years without any degradation.
- ✓ They incorporated some biodegradable materials with plastics and made them easily and rapidly degradable.

DEAD ANIMALS:

- ✓ Dead animals are those that die naturally or are accidentally killed on the road. Example: Dead dogs, cats, rats etc.
- ✓ If not collected promptly, dead animals pose a threat to public health since they attract flies and other vermin as they decay.
- ✓ Their presence in public places is particularly offensive from the aesthetic point of view as well.

ABANDONED VEHICLES:

- ✓ This category includes automobiles, trucks and trailers that are abandoned on streets and other public places.

SEWAGE WASTES:

- ✓ They are mostly organic and derived from the treatment of organic sludge separated from both raw and treated sewages.

WASTE GENERATION RATES:

- ✓ Wastes generation is essential due to discarding of unwanted materials away for disposal.
- ✓ Huge quantities of municipal solid wastes are generated in all the megacities of the world.
- ✓ The volume of municipal solid wastes generated varies with the lifestyle of the people.
- ✓ Canada's estimated total waste generation is the largest in the entire world.
- ✓ Canada's estimated annual waste per capita is 36.1 metric tons.

FACTORS AFFECTING THE GENERATION OF SOLID WASTE:

- Geographic location
- Seasons
- Collection frequency
- Population density and diversity
- Per capita income
- Extent of salvaging and recycling
- Public attitude
- Legislation

GEOGRAPHIC LOCATION:

The influence of geographic location is related primarily to different climates that can influence both the number of certain types of solid wastes generated and the collection operation.

In the warmer southern areas, where the growing season is considerably longer compared to the northern areas, yard wastes are collected in considerably larger quantities and over a longer period of time.

SEASONS:

Seasons of the year have implications for the quantities and compositions of certain types of solid wastes.

The growing season of vegetable and fruits affect the quantities of food wastes.

For example, mango and melon peelings found are more in summers.

COLLECTION FREQUENCY:

In localities, where there are ultimate collection services, more wastes are collected.

POPULATION DENSITY AND DIVERSITY:

The characteristics of the population influence the quantity and composition of waste generated.

PER CAPITA INCOME:

The amount of waste generated is more in high income areas compared to that in low-income areas.

Similarly, the composition differs in terms of paper and other recyclable, which are typically more in high income areas as against low-income areas.

EXTENT OF SALVAGING AND RECYCLING:

The existence of salvaging and recycling operation within a community definitely affects the quantity of wastes collected.

PUBLIC ATTITUDE:

Significant reduction in the quantity of solid waste is possible, if and when people are willing to change their habits and lifestyles to conserve the natural resources and to reduce the economic burden associated with the management of solid wastes.

LEGISLATION:

This refers to the existence of local and state regulations concerning the use and disposal of specific materials and is an important factor that influences the composition and generation of certain types of wastes.

The Indian legislation dealing with packing and beverage container materials is an example.

INTEGRATED SOLID WASTE MANAGEMENT:

- Integrated solid waste management (ISWM) can be defined as the selection and application of suitable techniques, technologies and management programs to achieve specific waste management objectives and goals.
- The important principle in waste management is 3R's e.g., reduction, reuse and recycling.

COMPONENTS OF INTEGRATED SWM:

- ✓ Waste Minimization at source
- ✓ Material Recovery and Recycling
- ✓ Wastes Transformation
- ✓ Volume Reduction before Disposal
- ✓ Wastes Disposal
- ✓ Database Management

PRESENT SCENARIO OF SWM IN URBAN LOCAL BODIES:

- ✓ Solid waste management (SWM) has emerged as one of the most massive development challenges in urban India.
- ✓ Numerous studies indicate that the unsafe disposal of waste generates dangerous gases and leachates, due to microbial decomposition, climate conditions, refuse characteristics and land-filling operations.
- ✓ In India, approach towards waste management is unscientific.
- ✓ Even today, large portion of solid waste is dumped indiscriminately on outskirts of places without any prior treatment leading to groundwater contamination and increase in air pollution.

CURRENT ISSUES IN SWM IN INDIA:

- ✓ According to Dr Kumar, the major problems affecting solid waste management are unscientific treatment, improper collection of waste, and ethical problems.
- ✓ This in turn leads to hazards like environmental degradation, water pollution, soil pollution, and air pollution.
- ✓ Segregation can help reduce the burden of transportation of waste as well as lower leachate and greenhouse gas (GHG) emissions.
- ✓ If the waste is segregated at source, various components can be utilized in different types of production processes, generating marketable use value.

CAUSES OF URBAN WASTE:

- ✓ An increasing population, changing consumption patterns, economic development, improving household incomes, growing urbanization and industrialization have resulted in increased urban waste-generation.

MANAGE WASTE IN URBAN AREAS:

- ✓ Composting is an environment- friendly and simple solution for organic waste that is often successful at the house- hold level.
- ✓ Another option is biogas production, which can be used to produce electricity or as fuel for vehicles.
- ✓ Waste disposal can be improved by constructing different types of sanitary landfills.

DUMPING OF SOLID WASTE:

- ✓ Dumping or Land Filling is an old way of disposing off wastes. It is an easy method of disposal of dry refuse.
- ✓ In this process, solid wastes are dumped in a low-lying area and as a result of bacterial action, refuse decreases considerably in volume and are converted gradually into humus.

TYPES:

- Open dumping:

- ✓ In this method, waste materials are dumped in open low lands far away from the city.
- ✓ This method is not environment friendly. The waste then is subjected to bacterial decomposition.

- Sanitary landfill:

- ✓ In this method, the waste is packed and dumped daily at the site and is covered with earth to prevent insects or rodents from entering into the landfill.

CAUSES OF DUMPING OF SOLID WASTE:

- ✓ Solid waste pollution is caused mainly through urbanization and through industrial waste.
- ✓ It causes various diseases in human as bacillary dysentery, diarrhea and amoebic dysentery, plague, salmonellosis, trichinosis, endemic typhus, cholera, jaundice, hepatitis, gastro enteric diseases etc.

METHODS OF DISPOSAL OF SOLID WASTE:

- ➢ Preventing or Reducing Waste Generation
- ➢ Recycling
- ➢ Incineration
- ➢ Composting
- ➢ Sanitary Landfill
- ➢ Disposal in Ocean/Sea

PREVENTING OR REDUCING WASTE GENERATION:

- ✓ Extensive use of new or unnecessary products is the root cause of unchecked waste formation.
- ✓ The rapid population growth makes it imperative to use secondhand products or judiciously use the existing ones because if not, there is a potential risk of people succumbing to the ill effects of toxic wastes.
- ✓ Disposing of the wastes will also assume formidable shape. A conscious decision should be made at the personal and professional level to judiciously curb the menacing growth of wastes.

RECYCLING:

- ✓ Recycling serves to transform the wastes into products of their own genre through industrial processing.
- ✓ Paper, glass, aluminum, and plastics are commonly recycled.
- ✓ It is environmentally friendly to reuse the wastes instead of adding them to nature.
- ✓ However, processing technologies are pretty expensive.

INCINERATION:

- ✓ Incineration features combustion of wastes to transform them into base components, with the generated heat being trapped for deriving energy.
- ✓ Assorted gases and inert ash are common by-products.
- ✓ Pollution is caused by varied degrees dependent on nature of waste combusted and incinerator design.

- ✓ Use of filters can check pollution.
- ✓ It is rather inexpensive to burn wastes and the waste volume is reduced by about 90%.
- ✓ The nutrient rich ash derived out of burning organic wastes can facilitate hydroponic solutions.
- ✓ Hazardous and toxic wastes can be easily be rid of by using this method.
- ✓ The energy extracted can be used for cooking, heating, and supplying power to turbines.
- ✓ However, strict vigilance and due diligence should be exercised to check the accidental leakage of micro level contaminants, such as dioxins from incinerator lines.

COMPOSTING:

- ✓ It involves decomposition of organic wastes by microbes by allowing the waste to stay accumulated in a pit for a long period of time.
- ✓ The nutrient rich compost can be used as plant manure.
- ✓ However, the process is slow and consumes a significant amount of land.

Biological reprocessing tremendously improves the fertility of the soil.

SANITARY LANDFILLS:

- ✓ Sanitary landfills are sites where waste is isolated from the environment until it is safe.
- ✓ It is considered when it has completely degraded biologically, chemically and physically.
- ✓ In high-income countries, the level of isolation achieved may be high.
- ✓ A landfill site, also known as a tip, dump, rubbish dump, garbage dump, or dumping ground, is a site for the disposal of waste materials.
- ✓ Landfill is the oldest and most common form of waste disposal, although the systematic burial of the waste with daily, intermediate and final covers only began in the 1940s
- ✓ Some landfill sites are also used for waste management purposes, such as temporary storage, consolidation and transfer, or for various stages of processing waste material, such as sorting, treatment, or recycling.
- ✓ Sanitary landfill, method of controlled disposal of municipal solid waste (refuse) on land.
- ✓ The method was introduced in England in 1912 (where it is called controlled tipping).
- ✓ Waste is deposited in thin layers (up to 1 metre, or 3 feet) and promptly compacted by heavy machinery (e.g., bulldozers); several layers are placed and compacted on top of each other to form a refuse cell (up to 3 metres, or 10 feet, thick).

- ✓ At the end of each day the compacted refuse cell is covered with a layer of compacted soil to prevent odours and windblown debris.
- ✓ All modern landfill sites are carefully selected and prepared (e.g., sealed with impermeable synthetic bottom liners) to prevent pollution of groundwater or other environmental problems.
- ✓ When the landfill is completed, it is capped with a layer of clay or a synthetic liner in order to prevent water from entering.
- ✓ A final topsoil cover is placed, compacted, and graded, and various forms of vegetation may be planted in order to reclaim otherwise useless land.

DISPOSAL IN OCEAN/SEA:

- ✓ Wastes generally of radioactive nature are dumped in the oceans far from active human habitats.
- ✓ However, environmentalists are challenging this method, as such an action is believed to spell doom for aquatic life by depriving the ocean waters of its inherent nutrients.
- ✓ Ocean waste disposal has been practiced throughout human history.
- ✓ It consists of dumping materials from land or from a vessel, or discharging them through a pipe into marine waters.

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – II – WASTE WATER MANAGEMENT– SCIA4002

INTRODUCTION

SANITARY ENGINEERING:

It is defined as the branch of public health engineering deals with the collection, conveyance, treatment and safe disposal of wastes for preventing the communicable diseases.

STAGES OF SANITARY ENGINEERING:

Conveyance of sewage

Collection of sewage

Treatment of sewage

Disposal of sewage

OBJECTIVES OF SANITARY ENGINEERING:

To maintain the environment and to prevent the effect of sewage to public health in general.

To prevent the effect of disposal of sewage on land or nearby water bodies from pollution.

To prevent the environment from mosquitoes, flies, bacteria etc.

To dispose the human excreta to a safe place before it starts decomposition.

SEWAGE:

It is a dilute mixture of the wastes of various types from the residential, public and industrial places.

It includes sullage water and foul discharge from the water closets, urinals, hospitals, stables etc.

CLASSIFICATION OF SEWAGE:

SANITARY SEWAGE:

It is the sewage obtained from the residential buildings & industrial effluents Establishments.

Being extremely foul it should be carried through underground conduits.

DOMESTIC SEWAGE:

It is the sewage obtained from the lavatory basins, urinals & water closets of houses, offices & institutions.

It is highly foul on account of night soil and urine contained in it.

Night soil starts putrefying & gives offensive smell.

It may contain large number of bacteria due to the excremental wastes of patients.

This sewage requires great handling &disposal.

INDUSTRIAL SEWAGE:

It consists of spent water from industries and commercial areas.

The degree of foulness depends on the nature of the industry concerned and processes involved.

SULLAGE:

It is defined as the waste water from domestic buildings especially from bathrooms, kitchens etc.

It is merely waste water and does not create any bad smell or odour.

SLUDGE:

It is the organic matter deposited in the sedimentation tank during treatment.

SEWERAGE:

The entire system of collecting, carrying & disposal of sewage through sewers is known as sewerage.

The sewerage system carries two types of flow:

1. DRY WEATHER FLOW (DWF):

Domestic sewage and industrial sewage collectively, is called as DWF.

It does not contain storm water.

It indicates the normal flow during dry season.

2. WET WEATHER FLOW (WWF):

The flow of storm water is called WWF.

SEWERS:

Sewers are underground pipes which carry the sewage to a point of disposal.

TRUNK SEWERS:

A trunk sewer is a one which collects the waste water or sewage from two or more main sewers.

MAIN SEWERS:

A main sewer is a one which collects the sewage from two or more sub main sewers.

SUB MAIN or BRANCH SEWERS:

A sub main or branch sewer is a one which collects the sewage from lateral sewers and discharges into main sewer.

LATERAL SEWER:

The sewer collecting the sewage directly from the building and discharging to the branch sewer is called lateral sewer.

COMBINED SEWER:

A sewer carries domestic sewage and storm water is called combined sewer.

OBJECTIVES OF WASTE WATER TREATMENT

- The purpose of waste water treatment is to remove contaminant from water so that the treated water can meet the acceptable quality standard.
- The quality standard usually depends whether the water will be reused or discharged into river.
- Before disposing of sewage into river or land, sewage has to be treated to make it safe and to make it harmless.
- Methods of waste water treatment depends on composition of waste water and required quality for treated water.
- Treatment process are broadly classified as physical, chemical and biological treatments.
- Physical treatment methods utilize physical separation of pollutant such as by filtration etc.
- Chemical treatment methods utilize chemical characteristics of pollutant for purification. For e.g., Coagulation etc.
- Biological treatment methods utilize biological characteristics of pollutants such as bacteria, viruses by purification.
- Other purpose of waste water treatment includes:

- ✓ To reduce strength of sewage
- ✓ To make waste water less offensive
- ✓ To prevent public health from toxic effect of pollutant
- ✓ To conserve nature

LAYOUT OF SEWAGE TREATMENT PLANT

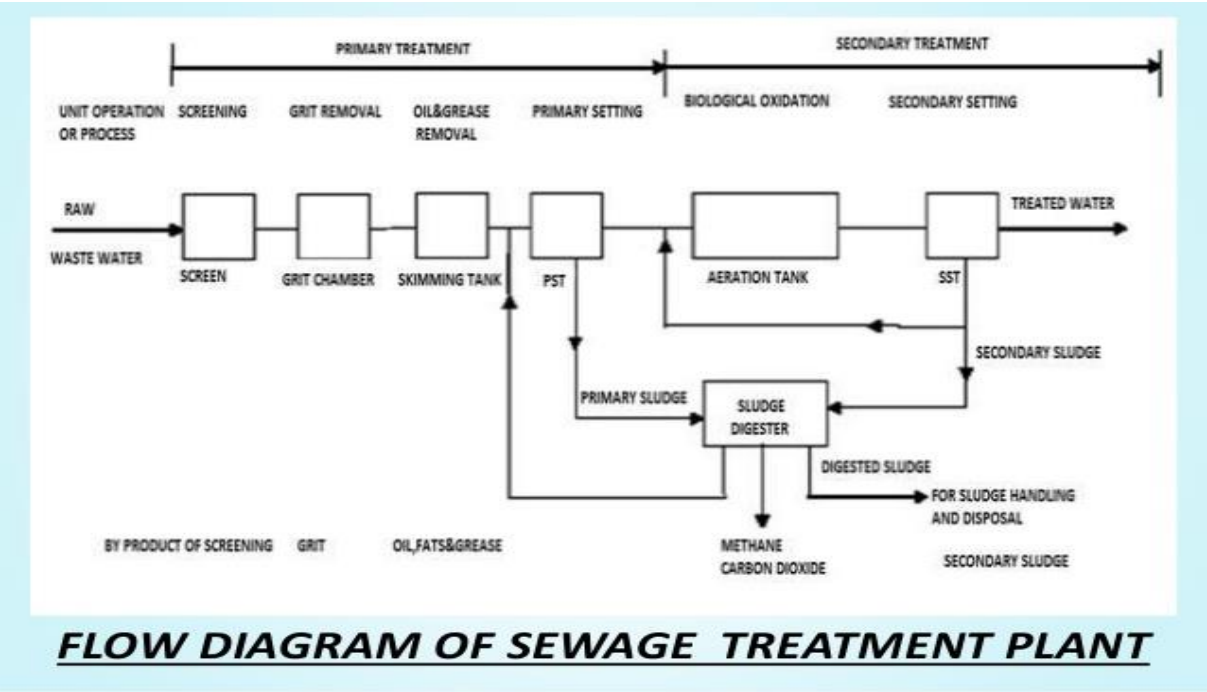


Figure No.1

STEPS OF SEWAGE TREATMENT PROCESS:

The four processes are:

- ✓ Preliminary Treatment
- ✓ Primary Treatment
- ✓ Secondary or Biological Treatment
- ✓ Tertiary or Advanced or Final Treatment.

PRELIMINARY TREATMENT OF WASTEWATER:

It is the first stage in treatment process, in which the floating materials such as tree branches, dead animals, papers, pieces of rags, wood etc. are separated from the sewage.

FUNCTIONS OF PRIMARY TREATMENT:

- ✓ Removes oils and greases.
- ✓ Reduces the BOD of sewage about 25 %.
- ✓ Removes larger settleable, in-organic solids etc.

Some of the treatment technique applied for preliminary treatment purpose are:

- ✓ Screening

- ✓ Grit removal
- ✓ Skimming

SCREENING:

- ✓ Screening is the first unit operation in waste water treatment plants.
- ✓ Screens are devices with openings of uniform size and the screening units may consists of parallel bars, rods, gratings or wire mesh or perforated plates.
- ✓ Screens may be of any shape and generally they are rectangular or circular.

PURPOSE:

- ✓ Screening is used to remove the floating matters of comparatively larger in size like plastics, clothes, dead animals from waste water.
- ✓ If the larger materials are not removed, they will clog or damage the valves, appurtenances, small pipes and pumps etc.

Figure No.2

TYPES OF SCREENS:

Screens are classified,

According to the size of openings:

- Coarse Screen
- Medium
- Fine Screen

According to the movement of screens:

- Fixed Screen
- Movable Screen
- Moving Screen

COARSE SCREEN:

- ✓ The coarse screens are also called as racks are having the space between the bars of 40 mm.
- ✓ The coarse screens reduce the organic load of sewage considerably.
- ✓ Hand cleaned coarse screens are generally set at an angle of 45 inclination to the direction of flow.
- ✓ Mechanically cleaned coarse screens are generally set almost vertically.

MEDIUM SCREEN:

- ✓ Medium screens are having the opening of 6 mm to 40 mm.
- ✓ It removes organic load of sewage to small extent and it is not much significance in the further treatment.

FINE SCREEN:

- ✓ Fine screens are mechanically cleaned devices using perforated plate of very closely spaced bars with clear openings of less than 6 mm.
- ✓ They are used for pre-treatment of industrial wastes to remove materials which tend to produce excessive scum or foam on the top of the digestion tank contents.
- ✓ Fine screens are generally not suitable for sewage because of clogging of screens.
- ✓ Fine screens are mechanically cleaned and may be of drum or disc type and continuously operated by electric motors.
- ✓ Fine screens are generally made of metal plates.

FIXED SCREEN:

- ✓ Fixed screens are permanently set in position.
- ✓ A perforated platform is provided to receive the material collected from the screen bars.

MOVABLE SCREEN:

- ✓ The movable screens are stationary during their operation.
- ✓ But during cleaning and maintenance, they can be lifted up and removed from their position.

MOVING SCREEN:

- ✓ The moving screens are moving during their operating period and they are automatically cleaned when they are in motion.

DISPOSAL OF SCREENINGS:

Following four methods are generally adopted for the disposal of screenings:

- ✓ Burial
- ✓ Incineration
- ✓ Disintegration
- ✓ Fertilizer

GRIT BASINS or GRIT CHANNELS:

- ✓ Sewage contains both organic and inorganic materials, and grit is the heavy mineral material found in raw sewage, it may contain sand, gravel, silt, cinders, broken glass, small fragments of metal and other inorganic solids.
- ✓ Grits are small, non-biodegradable particles which are heavier than suspended organic matters.
- ✓ Grits are removed by carefully regulating the flow velocity of sewage in grit removal tank.
- ✓ They reduce the excessive accumulation of grit in such units.
- ✓ Grit chambers are provided to remove grit, sand and other inorganic matter from the sewage.
- ✓ Grit chambers are provided to protect moving mechanical equipment from abrasion.

- ✓ They reduce the formation of heavy deposits in channels, pipelines or conduits.

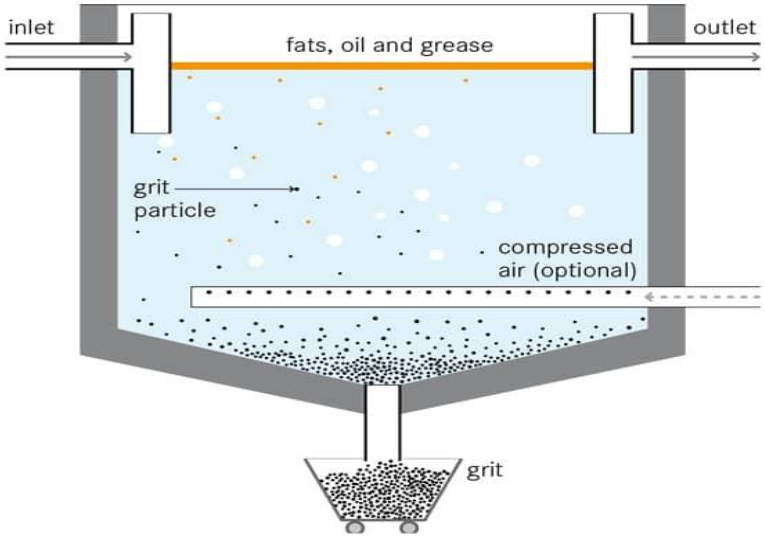


Figure No.3

SOURCES:

- ✓ The grit in sewage is obtained from domestic sewage, floors of garages and service stations, first storm of the season etc.
- ✓ Grit may enter the sewage through storm water discharge of road washings and from kitchens.

TYPES OF GRIT CHAMBERS:

- ✓ Horizontal Flow Type
- ✓ Vertical Flow Type

DISPOSAL OF GRIT:

- ✓ Grit is disposed of mostly in the low-lying areas to reclaim such lands.
- ✓ It can also be mixed with poor soil to condition it.

OIL AND GREASE REMOVAL:

Grease in sewage includes fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils and other non-fatty materials.

Oil and grease are obtained from restaurants, kitchens, garages, soap and candle factories, oil refineries and slaughter houses.

The oil and grease create following severe problems and difficulties in sewerage system.

If sewage with oil and grease is disposed into the stream, the foul odour may be produces at the surface of the stream.

They reduce the efficiency of other treatment units and clog the trickling filter.

The digestion of oils and grease is a difficult one for sludge digestion tank.

They affect the biological action of microorganism.

They can be removed from sewage either by floatation or as a scum or sludge.

Formation of scum is promoted by diffusing air through sewage.

SKIMMING:

- ✓ Skimming is the process of removal of fatty and oily material from sewage.
- ✓ In this method, sewage is placed in skimming tank and it is aerated from bottom so that fats and oils are collected at top of the liquid which are then removed by skimming.
- ✓ The tank in which scum formation is carried out by diffusion of air through the sewage is called skimming tanks.

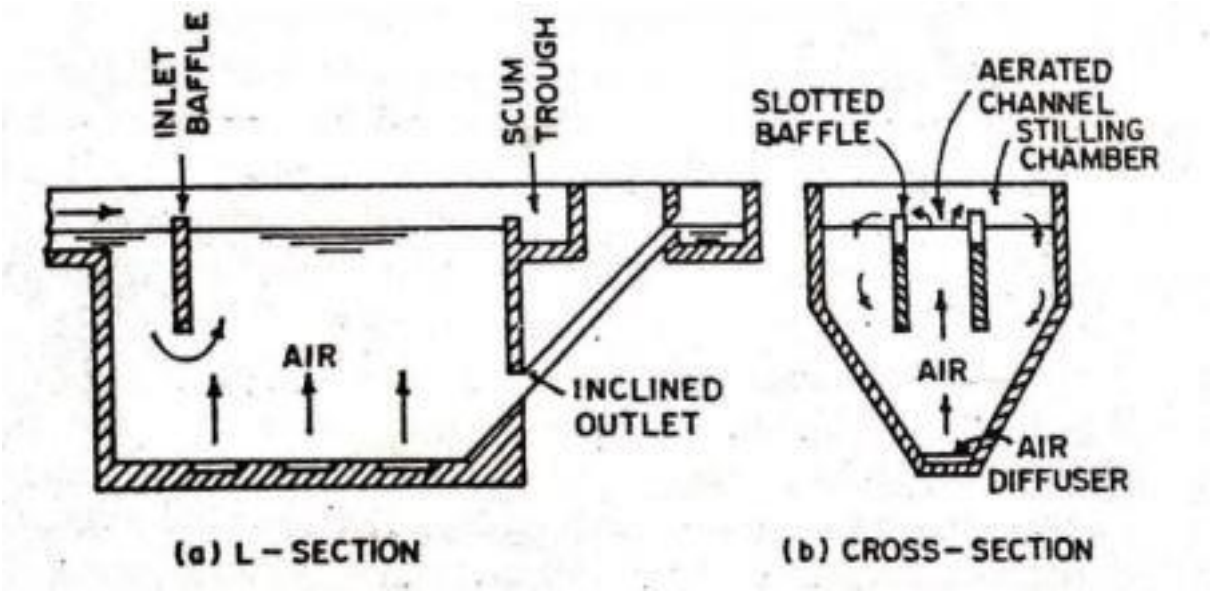


Figure No.4

DISPOSAL OF SKIMMIMGS:

- ✓ The oil and greasy materials removed by skimming tanks are disposed either by burning or burial.
- ✓ Sometimes, the disposal of skimmings can be converted into soap lubricants, candle and other non-edible products.
- ✓ Sometimes, it may be digested in digesters, when the vegetable and organic matters present are more, and when this is more, digest easily and produces high fuel value gases.

PRIMARY TREATMENT OF WASTEWATER:

After removal of floatable solids, grits and fats, next step in treatment is removal of remaining suspended solids as much as possible.

The main objective of primary treatment is to reduce strength of sewage by removing suspended materials.

Some common technique applied for primary treatment of sewage are:

- ✓ Sedimentation tanks
- ✓ Imhoff tanks
- ✓ Septic tanks
- ✓ Chemical precipitation tanks

SEDIMENTATION:

- ✓ Sedimentation tank is used for removal of suspended solids and some organic matters.
- ✓ The process of sedimentation reduces the strength of sewage to the extent of about 30 to 35 percent.
- ✓ The quantity of settleable solids in the sewage is reduced to the extent of about 80 to 90 %.
- ✓ About 30 to 35 % of BOD is removed.
- ✓ If the velocity of flow of sewage is reduced, the suspended particles present in the sewage, tend to settle at the bottom of the tank.
- ✓ The material collected at the bottom of the tank is called sludge and the partially treated sewage are called effluent.

- ✓ Sedimentation tanks are also known as settling tanks or wastewater clarifiers.

TYPES OF SEDIMENTATION TANK:

Classification based on the purpose:

- ✓ Grit Chamber
- ✓ Plain sedimentation
- ✓ Chemical Precipitation tank
- ✓ Septic tank
- ✓ Imhoff tank
- ✓ Secondary settling tank

Classification based on direction of flow:

- ✓ Horizontal flow settling tank
- ✓ Vertical flow settling tank
- ✓ Radial flow settling tank

Classification based on nature of working:

- ✓ Fill and Draw type
- ✓ Continuous flow type
- ➢ Classification based on location:
- ✓ Primary sedimentation tank
- ✓ Secondary sedimentation tank

RECTANGULAR SEDIMENTATION TANK:

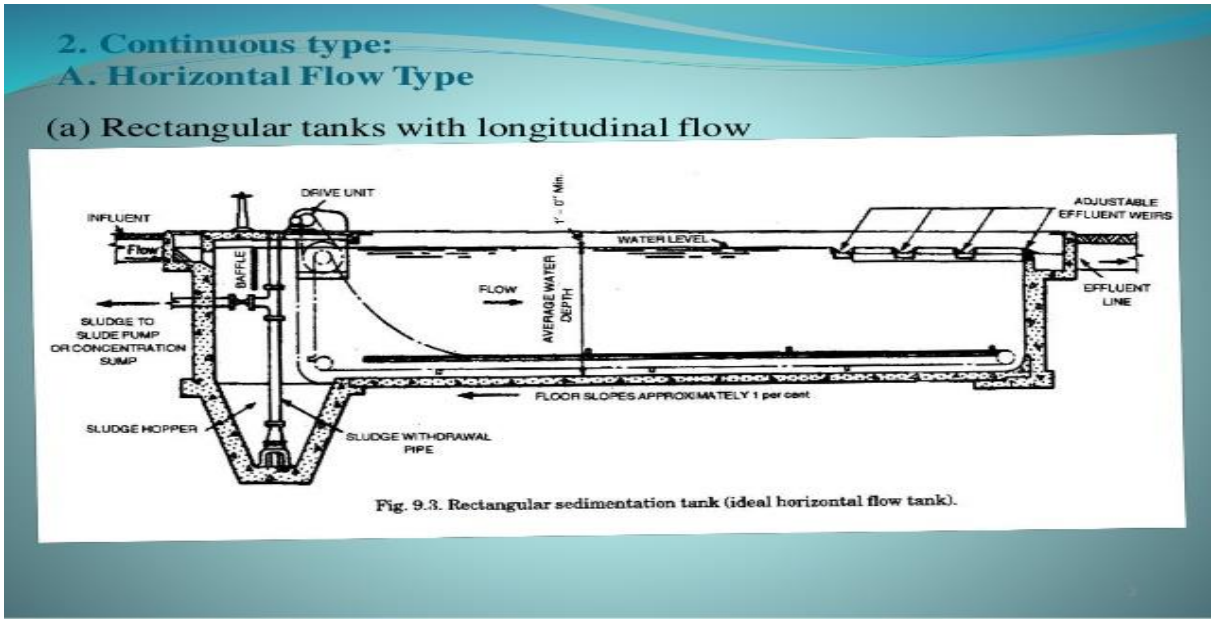


Figure No.5

CONSTRUCTION DETAILS OF RECTANGULAR TANK:

- ✓ Inlet and Outlet Arrangements
- ✓ Baffles
- ✓ Skimming Troughs
- ✓ Cleaning and Sludge Removal

INLET AND OUTLET ARRANGEMENTS:

- ✓ In order to distribute the uniform flow, some special arrangement is to be made for smooth entry of sewage.
- ✓ The most suitable type of an inlet for a rectangular tank is in the form of a channel extending to full width of the tank with a submerged weir type baffle wall.
- ✓ The similar type of outlet arrangement is used for the smooth exit of the sewage.
- ✓ It consists of an outlet, extending for full width of the tank and receiving the waste water after it has passed over a weir.

BAFFLES:

Baffles are required to prevent the movement of organic matter and its escape along with effluent.

Baffles are provided in the form of troughs or boards for the following purposes:

- To prevent the entry of floating substances into the outlet channel.
- To distribute the sewage uniformly through the cross section of the tank.

SKIMMING TROUGHS:

- ✓ When the amount of oils and greasy matters present in sewage is small, it is uneconomical to provide a separate skimming tank.
- ✓ In such cases, a skimming trough is provided near its outlet end of sedimentation tank.
- ✓ In manually operated tanks, skimmings that float on surface may be pushed into trough by squeezes with hand.
- ✓ In mechanically operated tanks, skimmings may be pushed by a same scraper blades which collect sludge while moving bottom and push the skimmings into trough when they move near the surface along with endless chain to which they are attached.

CLEANING AND SLUDGE REMOVAL:

- ✓ Suspended organic solids settle down at the bottom of tank and is to be removed periodically.
- ✓ It is necessary before it becomes stale and septic.
- ✓ It is necessary because it reduces the capacity of tank and its detention period.
- ✓ Also, it leads to the evolution of foul gases formed due to anaerobic decomposition.
- ✓ Hence cleaning is to done from time to time at frequent intervals, either manually or mechanically.
- ✓ For tanks without mechanical sludge removing equipment additional minimum depth of about 0.8 - 1.2 m should be provided for storage of settled materials and is called sludge zone.

SEDIMENTATION WITH COAGULATION:

Very fine suspended particles of wastewater cannot be removed by plain or primary sedimentation tank and they can be settled by increasing their size by changing them into flocculated particles.

Sedimentation with coagulation is defined as the process of removing the very fine suspended particles present in the waste water that cannot be removed by primary sedimentation by increasing their size by using chemicals.

The chemicals used for increasing the size of the particles are called coagulants.

The various chemicals or coagulants are:

- ✓ Alum
- ✓ Ferric Chloride
- ✓ Ferric Sulphate
- ✓ Chlorinated Copperas.

The coagulants mixed with water forms a gelatinous precipitate called floc, which attracts the fine mud particles and other colloidal matters form a bigger sized flocculated particle.

The process of adding the chemicals is called coagulation and the formation of bigger sized flocculate particles is called flocculation.

SECONDARY TREATMENT OF WASTE WATER:

The effluent from the primary sedimentation tank consists of 45 to 60 % of unstable organic matters, originally present in the sewage.

The larger and medium sized solids have been removed by settling in sedimentation tanks and the organic matter present in the sewage as colloidal matter is carried away by effluent from the settling tanks.

The further treatment of sewage is called secondary treatment or biological treatment and in which the conversion of organic matter into stable forms by oxidation or nitrification.

The secondary treatment of sewage involves various methods and are classified into two important processes.

- ✓ Filtration process
- ✓ Activated-sludge process.

All the secondary treatment processes are designed to work on aerobic bacterial decomposition.

In secondary treatment, dissolved or colloidal organic matters are present in sewage are removed by utilizing microorganisms.

In this step, microorganisms utilize organic matter and converts them into inorganic minerals.

Following changes occurs in sewage during secondary treatment:

- Organic matter (carbon) is oxidized into CO_2 and H_2O
- Organic nitrogen compounds are first converted into NH3 and then into NO3
- Colloidal matters are coagulated or precipitated out.

Thus, main purpose of secondary treatment of sewage is to reduce BOD level.

FILTRATION PROCESS:

- ✓ In secondary treatment, the filter units consist of open beds of coarse aggregate over which the sewage is spreaded or sprinkled intermittently.
- ✓ The necessary contact surface for the growth of aerobic bacteria is provided by the aggregates in the bed.
- ✓ By doing this, the aeration is provided by nature.

DIFFERENT TYPES OF FILTERS:

- ✓ Contact Beds
- ✓ Intermittent Sand Filters
- ✓ Trickling Filters

TRICKLING FILTERS:

Trickling filter

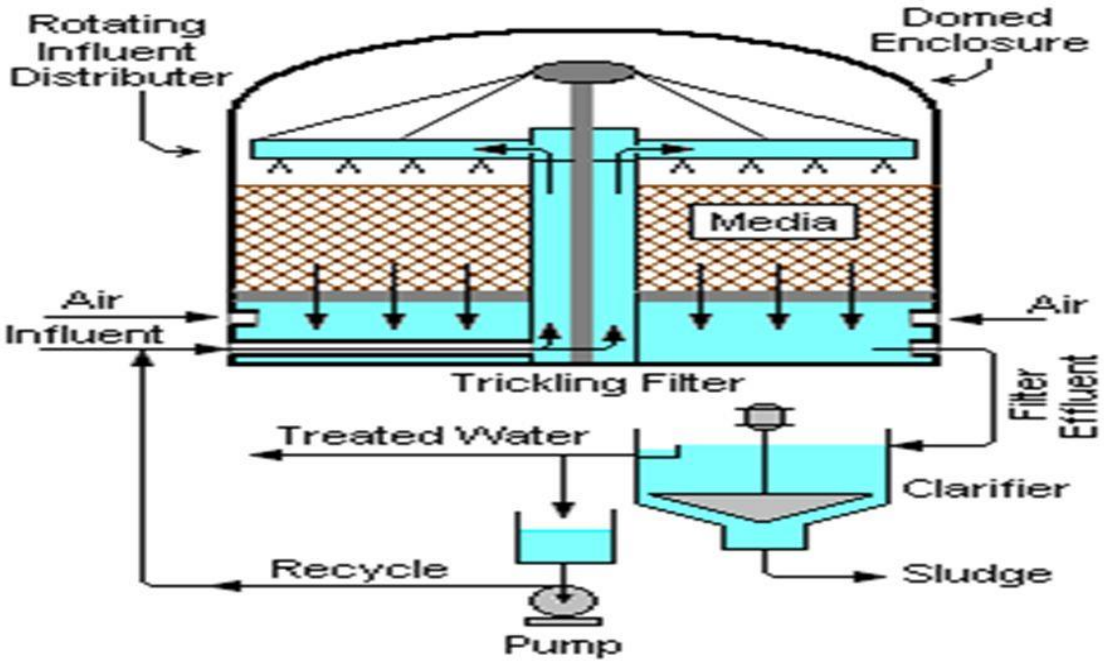


Figure No.6

- Trickling filters (TFs) are used to remove organic matter from wastewater.
- The TF is an aerobic treatment system that utilizes microorganisms attached to a medium to remove organic matter from wastewater.
- This type of system is common to a number of technologies such as rotating biological contactors and packed bed reactors (biotowers).
- These systems are known as attached-growth processes.
- Trickling filter is an attached growth process i.e., process in which microorganisms responsible for treatment are attached to an inert packing material.
- Packing material used in attached growth processes include rock, gravel, slag, sand, redwood, and a wide range of plastic and other synthetic materials.
- The wastewater in trickling filter is distributed over the top area of a vessel containing non-submerged packing material.

- Air circulation in the void space, by either natural draft or blowers, provides oxygen for the microorganisms growing as an attached biofilm.
- During operation, the organic material present in the wastewater is metabolized by the biomass attached to the medium.
- The biological slime grows in thickness as the organic matter abstracted from the flowing wastewater is synthesized into new cellular material.
- The thickness of the aerobic layer is limited by the depth of penetration of oxygen into the microbial layer.
- The micro-organisms near the medium face enter the endogenous phase as the substrate is metabolized before it can reach the micro-organisms near the medium face as a result of increased thickness of the slime layer and lose their ability to cling to the media surface.
- The liquid then washes the slime off the medium and a new slime layer starts to grow. This phenomenon of losing the slime layer is called sloughing.
- The sloughed off film and treated wastewater are collected by an underdrainage which also allows circulation of air through filter.
- The collected liquid is passed to a settling tank used for solid- liquid separation.

ADVANTAGES:

- ✓ Can be operated at a range of organic and hydraulic loading rates.
- ✓ The mechanical wear and tear are small as it contains less mechanical equipment.
- ✓ Resistant to shock loadings.
- ✓ Efficient nitrification (ammonium oxidation)
- ✓ High effluent quality in terms of BOD and suspended solids removal; in combination with a primary and tertiary treatment also in terms of pathogens.
- ✓ The moisture content of sludge obtained from the trickling filters is as high as 99 %.
- ✓ Low power requirements.

- ✓ The working of trickling filters is simple and it does not require skilled supervision.
- ✓ The trickling filters may reduce the B.O.D and colloidal matter to the extent of about 75 % and 80 % respectively.
- ✓ The trickling filters are flexible in operation.

DISADVANTAGES:

- ✓ The cost of construction of trickling filters is high.
- ✓ Requires large land area and regular operator attention.
- ✓ Vector and odour problems.
- ✓ Incidence of clogging is relatively high.
- ✓ The process requires primary treatment of sewage and hence, the raw sewage cannot be purified by this process.

USES:

- ✓ The process of trickling filters is becoming popular at present and the trickling filters, especially of high-rate type are adopted in the modern treatment plant of sewage.

TERTIARY OR FINAL TREATMENT OF WASTE WATER:

- ➢ Tertiary treatment of waste water is final treatment process in which all the chemical and biological agents are completely removed from sewage before disposal into river.
- ➢ After the primary and secondary treatment of sewage, the sewage is a stabilized and a harmless one.
- ➢ However, the primary and secondary treatments remove only conventional constituents like TSS, BOD, COD, Organic carbon. Nitrogen, phosphorus etc.
- ➢ The non-conventional compounds and other emerging compounds may still be present in sewage.
- ➢ Also, sewage contains some roundworms and bacterial pathogens that are difficult to control.
- ➢ All these factors affect the public health and therefore, the sewage needs to undergo tertiary treatment before disposal or reuse for industrial, agricultural and municipal purposes.

- The tertiary treatment required will be always based on the type of water reuse and degree of quality of the reclaimed water.

OBJECTIVES OF TERTIARY TREATMENT PROCESS:

- ✓ Removal of suspended solids
- ✓ Removal of dissolved solids like salts
- ✓ Removal of nitrate and phosphate
- ✓ Killing of microorganisms

REMOVAL OF SUSPENDED SOLIDS:

Suspended solids are removed by two methods:

- ✓ Microstraining:

- In this method, sewage is placed in rotating drum filter of pore size 25-35 µm and then drum is rotated.
- During rotation, clear water comes out of drum and suspended solids remains inside drum.

- ✓ Chemical coagulation and filtration:

- In this method, precipitating agents such as alum is added in sewage.
- Fine suspended solids adsorb to the surface of Al (OC)3 precipitate, finally precipitate with adsorbed solids are separated by filtration.

REMOVAL OF DISSOLVED SOLIDS LIKE SALTS:

- ✓ Adsorption by activated carbon:

- Dissolved solids can be removed by filtering the water through filter containing activated carbon particle.

- ✓ Reverse osmosis:

- Reverse osmosis removes dissolved solids like NaCl and microbial cells.

REMOVAL OF NITRATE AND PHOSPHATE:

- ✓ If sewage after treatment is to be discharge into river, nitrate and phosphate should be removed from sewage before disposal.
- ✓ It is because nitrate and phosphate cause eutrophication.
- ✓ These plant nutrients are removed by biological process.

- ✓ At first sewage is placed in a tank containing nitrifying bacteria.
- ✓ These bacteria convert ammonium salt and nitrite into nitrate.
- ✓ Then the sewage is placed into second tank containing denitrifying bacteria.
- ✓ These bacteria convert nitrate into Nitrogen gas that leaves the sewage.
- ✓ Phosphate is also removed by bacteria by microbial assimilation process.

KILLING OF MICRO-ORGANISMS:

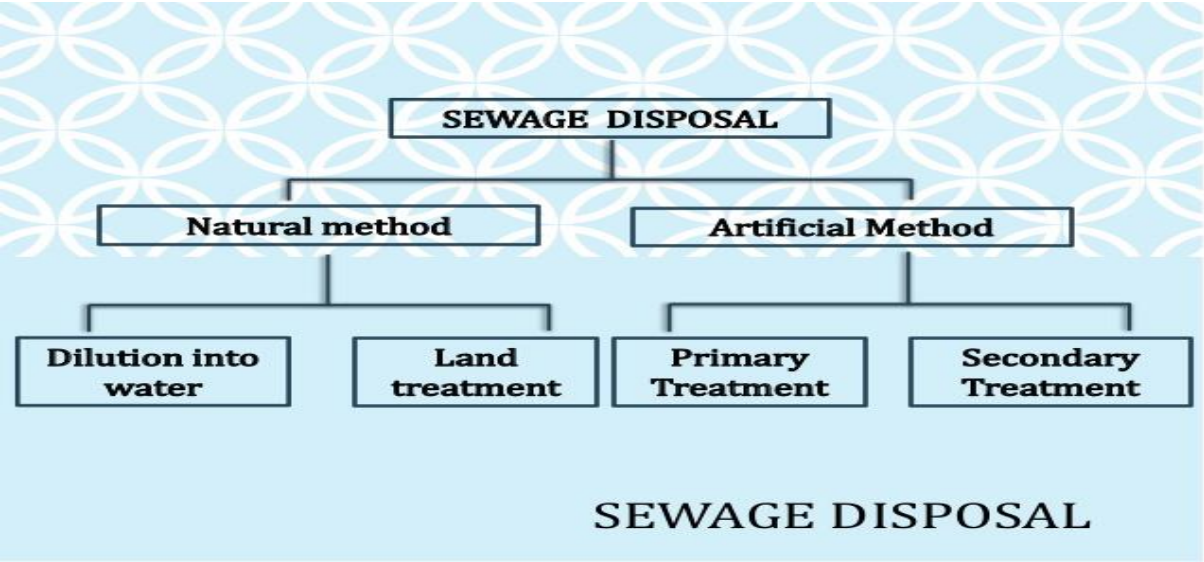
- ✓ Finally, microorganisms in sewage are killed by disinfection like chlorination.

STANDARDS FOR DISPOSAL

Standards of Dilution Based on Royal commission Report

Dilution Factor	Standards of purification required
Above 500	No treatment is required .Raw sewage can be directly discharged into the volume of dilution water
Between 300 to 500	Primary treatment such as plain sedimentation should be given to the sewage
Between 150 to 300	Treatments such a sedimentation, screening and essentially chemical precipitation are required
Less than 150	Complete thorough treatment should be given to sewage

METHODS OF SEWAGE DISPOSAL



CONDITIONS FOR DILUTION

- The city should be situated near the river, sea or lake.
- The sewage is comparatively fresh (4 to 5 hours old).
- The sewage should be free from all floating and settleable solids.
- The diluting water should not become a source of water supply.
- The area of point of disposal should not provide facilities for settling of solids and formation of sludge deposits.
- Diluting water should have high oxygen content.
- Completing mixing of the sewage with diluting water should be possible.
- The diluting waters should not be used for navigational purposes.

DILUTION FACTOR:

- ✓ The ratio of the quantity of the diluting water to that of the quantity of sewage is called Dilution Factor.
- ✓ If the dilution factor is less than 8, the sewage has to be completely purified under the following circumstances.

- The diluting water has more than 20 ppm of D.O in 5 days.
- The river is being used as a source of water supply on the downstream side.
- The effluent has to be used disposed of into tidal waters which may be in the form of river or sea.

SELF-PURIFICATION OF RIVER:

- When sewage is discharged into natural waters. Its organic matter gets oxidized by the dissolved oxygen content in water, and the receiving water gets polluted due to the waste products, present in the sewage effluents.
- But this is not happening always due to the natural forces of purification.
- The oxidation of organic matter converts the organic matter to simple harmless substances. The deficiency of dissolved oxygen is filled by the absorption of atmospheric oxygen.
- Thus, the oxygen of water is consumed by the sewage and at the same time, the oxygen is taken from the atmosphere.

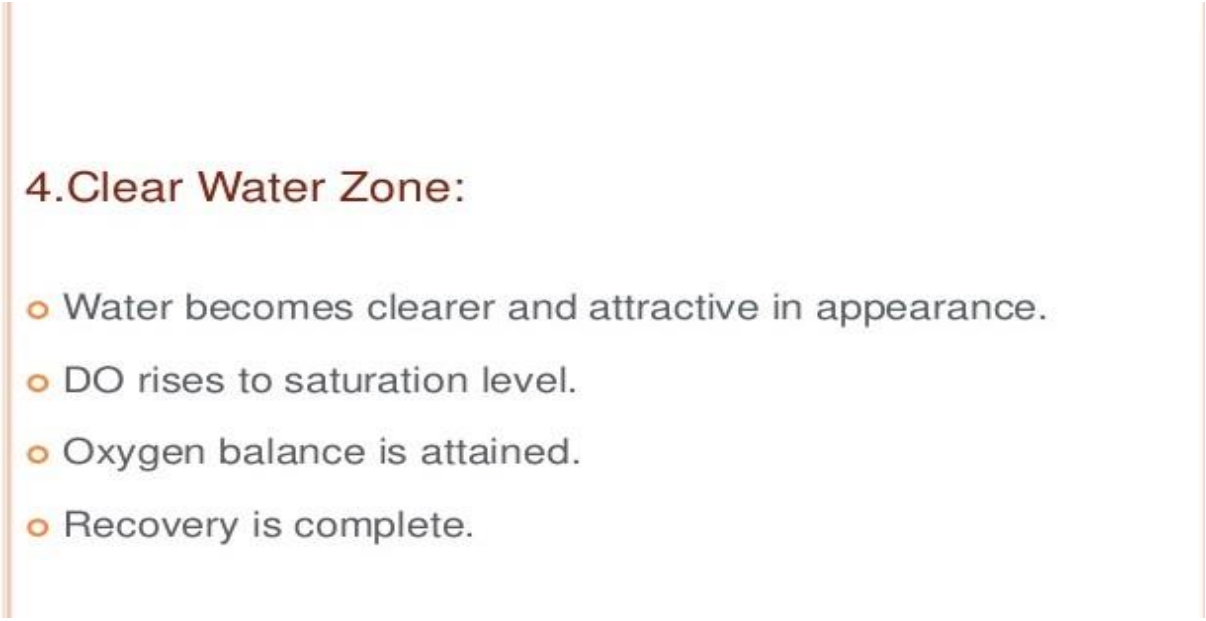
- This procedure occurs in all-natural waters is called Self-purification of natural waters.
- The rate of self-purification will depend on various factors such as rate of re=aeration, type of organic matter present in the sewage, temperature, velocity of flow, presence of available oxygen in receiving waters, sedimentation etc.
- The self-purification of process of streams polluted by sewage can be grouped in the following four zones or divisions.
- Degradation Zone
- Active-Decomposition Zone
- Recovery Zone
- Clear water Zone

2.ZONE OF ACTIVE DECOMPOSITION:

- Water in this zone becomes grayish and darker than previous zone.
- DO concentration falls to zero.
- Fish life is absent and bacteria is present.
- At the end of this zone DO rises to 40% of saturation.
- Aquatic life starts to reappear.

3.ZONE OF RECOVERY;

- Process of recovery starts.
- Stabilization of organic matter takes place into this zone.
- BOD falls and DO content increase above 40% value.
- NO_2 , SO_4 and CO_3 are formed.
- Near the end of this zone entire aquatic life reappears.



SOURCES OF GETTING OXYGEN:

- ✓ The oxygen required for the self-purification is obtained by natural waters from the atmosphere in the following three ways.
- ➢ **RAIN:**
- ✓ The rain water is saturated with oxygen and when combines with natural water results in increase of oxygen content.
- ➢ **SURFACE LEVEL:**
- ✓ The surface in natural water is in contact with the atmosphere.
- ✓ This surface absorbs oxygen from the atmosphere and passes it to the body of natural waters.
- ➢ **WAVES:**
- ✓ Some portion of air absorbed by waves and eddies of natural waters.
- ✓ The diffusion and dispersion due to the movement of fish in water will also encourage absorption of oxygen from the atmosphere.

FACTORS AFFECTING SELF PURIFICATION:

- ➢ DILUTION
- ➢ CURRENT
- ➢ TEMPERATURE
- ➢ SUNLIGHT
- ➢ RATE OF OXIDATION

DILUTION:

- ✓ When sufficient dilution water is available in the receiving water body, where the waste water is discharged, the DO level in the receiving stream may not reach to zero or critical DO due to availability of sufficient DO initially in the river water before receiving discharge of wastewater.

CURRENT:

- ✓ When strong water current is available, the discharged wastewater will be thoroughly mixed with stream water preventing deposition of solids.
- ✓ In small current, the solid matter from the wastewater will get deposited at the bed following decomposition and reduction in DO.

TEMPERATURE:

- ✓ The quantity of DO available in stream water is more in cold temperature than in hot temperature.
- ✓ Also, as the activity of microorganisms is more at the higher temperature, hence, the self- purification will take less time at hot temperature than in winter.

SUNLIGHT:

- ✓ Algae produces oxygen in presence of sunlight due to photosynthesis.
- ✓ Therefore, sunlight helps in purification of stream by adding oxygen through photosynthesis.

RATE OF OXIDATION:

- ✓ Due to oxidation of organic matter discharged in the river DO depletion occurs.
- ✓ This rate is faster at higher temperature and low at lower temperature.
- ✓ The rate of oxidation of organic matter depends on the chemical composition of organic matter.

OXYGEN SAG CURVE:

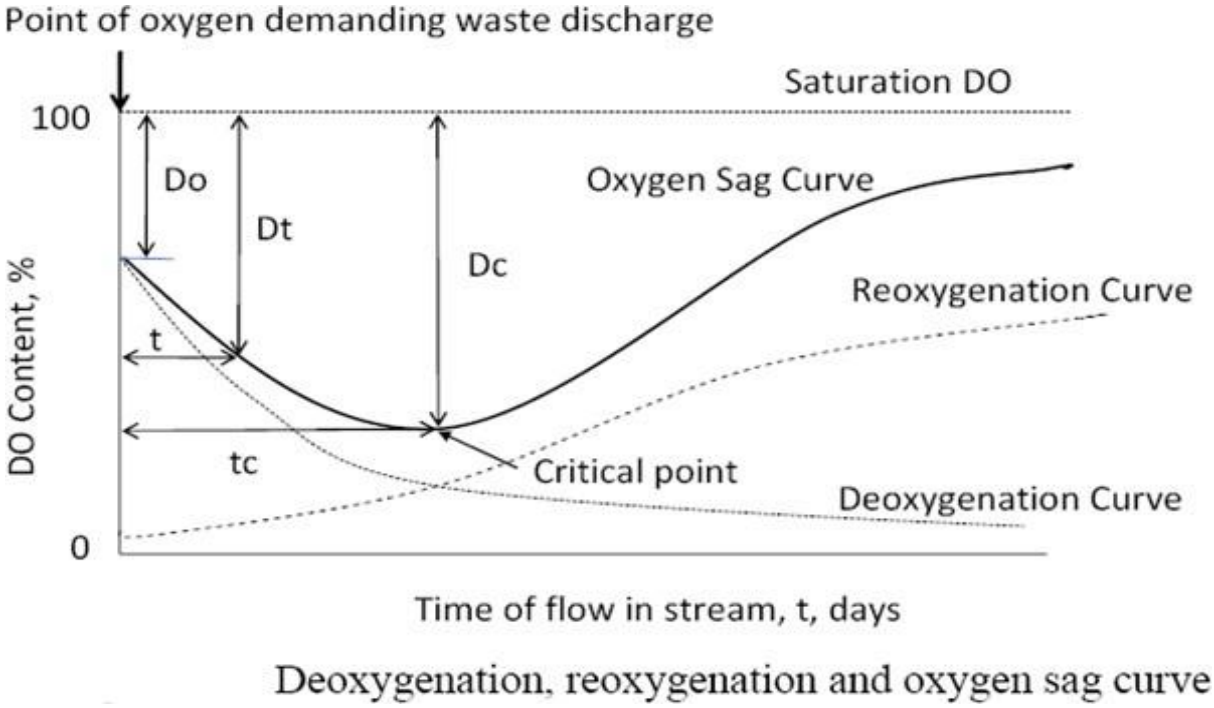


Figure No.7

DE-OXYGENATION CURVE:

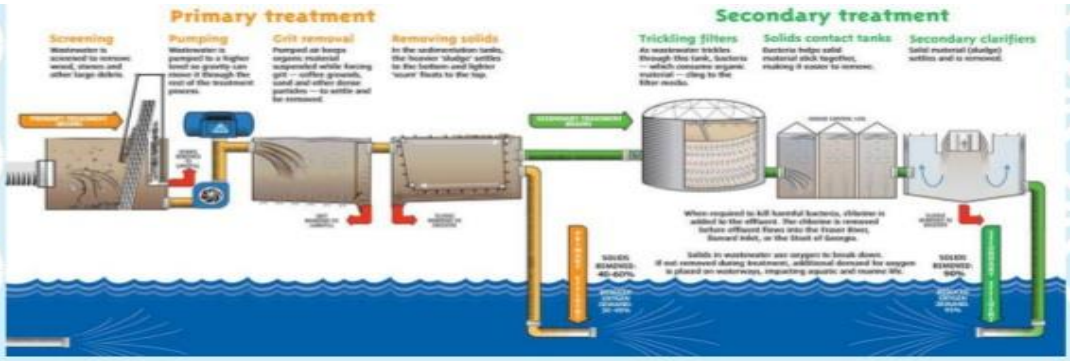
- ✓ The curve which represents (or) showing the depletion of D.O with time at the given temperature.

RE-OXYGENATION CURVE:

- ✓ In order to counter balance, the consumption of D.O due to the de – oxygenation, atmosphere supplies oxygen to the water and the process is called the re –oxygenation.
- ✓ When wastewater is discharged in to the stream, the DO level in the stream goes on depleting.
- ✓ This depletion of DO content is known as deoxygenation.
- ✓ When sewage is discharged into the river, the oxygen demand by the organic matter of sewage is satisfied.
- ✓ This is presented by the de-oxygenation curve.
- ✓ The ordinates below the de-oxygenation curve indicate the oxygen remaining in natural waters, after satisfying the oxygen demand.

- ✓ When de-oxygenation takes place, the deficiency or deficit of oxygen is filled up by the process of re-aeration. This is represented by the re-oxygenation curve.
- ✓ The rate of de-oxygenation becomes equal to the rate of re-oxygenation and the rate of re-aeration depends on the deficiency of oxygen developed by the sewage.
- ✓ The rate of re-oxygenation increases and the natural waters become saturated with D.O content as before.
- ✓ By using the above two curves, the quantity of net oxygen balance can be calculated at any stage of the self-purification process.
- ✓ This is represented by Oxygen sag curve or Oxygen deficit curve.
- ✓ When the rate of de-oxygenation is equal to the rate of re-oxygenation, the critical point of maximum deficit is reached.
- ✓ This point is shown on the oxygen sag curve and after this point is reached, the rate of re-oxygenation rapidly increases.
- ✓ Oxygen Deficit, D = Saturation D.O – Actual D.O

LAND DISPOSAL



DISADVANTAGES

- Additional land is required.
- If land is made up of heavy, sticky and fine grained soils, its voids get chocked and may create nuisance.
- Sanitary reasons may not permit growing of crops on sewage farms.

CONDITIONS FAVOURABLE FOR LAND TREATMENT

- The area of land treatment is composed of sandy, loamy or alluvial soils.
- Such soils are easily aerated and it is easy to maintain aerobic conditions in them.
- The depth of water table is more even in rainy season so that there are no chances of pollution of underground water sources by land treatment.
- The rainfall in the area is low as it will assist in maintaining good absorption capacity of soil.
- There is absence of river or other natural water sources in the vicinity of disposal of sewage.
- There is demand for cash crops which can be easily grown on sewage farms.
- There is availability of large open areas in the surrounding locality for practicing broad irrigation by sewage.

SEWAGE SICKNESS:

- ✓ If sewage is applied continuously on a piece of land, pores or voids of soil are filled up or clogged.
- ✓ Free circulation of air is thereby prevented and anaerobic conditions develop.

- ✓ At this stage, the land is unable to take any further sewage load.
- ✓ Organic matter decomposes and foul-smelling gases are produced.
- ✓ The phenomena of soil are known as sewage sickness of land.

PREVENTIVE MEASURES

In order to prevent sewage sickness of land, the following preventive measures may be adopted,

- ➢ **ALTERNATIVE ARRANGEMENT:**
- ✓ There should be ample provision of extra land so that land with sewage sickness can be given the desired rest.
- ✓ Alternatively, sewage should be disposed of by some other method when sewage farms are taking rest.
- ➢ **DEPTH OF SEWAGE:**
- ✓ If sewage is applied in excess, the chances of sewage sickness are increased.
- ✓ The land is unable to receive the excess sewage in a satisfactory way and it ultimately clogs up.
- ✓ Depth of sewage on land should be carefully decided by keeping in view the climatic conditions, drainage facilities, nature of crops and characteristics of soil.
- ➢ **DRAINAGE OF SOIL:**
- ✓ Subsoil drain pipes should be laid in sufficient number to collect the percolated effluent.
- ➢ **INTERMITTENT APPLICATION:**
- ✓ Sewage should be applied on land at intervals.
- ✓ The period between successive applications depends on general working of sewage farm and the permeability of soil.
- ✓ Depending on the nature of the soil, this period between successive applications varies from few hours to few weeks.
- ➢ **PRETREATMENT OF SEWAGE:**
- ✓ sewage should be given some pre-treatment before it is applied on land.

- **ROTATION OF CROPS:**

✓ It is desirable to grow different types of crops on a piece of land instead of one single crop.

✓ Rotation of crops minimizes the chances of sewage sickness.

- **TREATMENT TO LAND:**

✓ The land affected by sewage sickness should be properly treated before it is put up in use again.

✓ Clogged surfaces should be broken by suitable equipment.

PREVENTION OF SEWAGE SICKNESS:

✓ Primary treatment like screening & sedimentation should be given to sewage before its application to land so that suspended solids are removed & the pores of soil will not be clogged.

✓ The sewage should be applied intermittently on land i.e by giving rest to the land for some time.

✓ The land should be ploughed during non-supply period of sewage so that soil gets aerated.

✓ Keeping some portion of land reserved in order to use the same in resting period.

✓ Enough area will be required for this purpose.

✓ By planting different crops on the same land by rotation system of crops.

✓ The soil will be aerated & will utilize the fertilizing elements of sewage.

✓ By providing sufficient under drainage system to collect the excessive sewage quantity.

✓ By frequent ploughing & rotation of soil.

✓ By not applying the sewage in excess quantity.

SEWAGE FARMING:

- ✓ The process in which sewage is used for growing crops is known as sewage farming.
- ✓ The fertilizing elements of sewage i. e nitrates, sulphates, & phosphates are used by the roots of crops.
- ✓ The nutrients of sewage make the fields fertile.
- ✓ It is a profitable business & a good income can be generated by sewage farming.

OBJECTIVES OF SLUDGE TREATMENT:

- ➢ The sludge from primary sedimentation tank and sludge from secondary sedimentation units contains 96 % to 99 % of moisture content in its volume.
- ➢ Before disposing the sludge, the moisture should be removed in order to reduce the volume of sludge disposal.
- ➢ To reduce the cost of transport for heavy volume of disposal.
- ➢ To minimize the land requirement.
- ➢ To save the additional fuel required for incineration method of sewage disposal.

CHARACTERISTICS OF SLUDGE:

- ➢ The sludge has an objectionable odour and it may pollute the environment.
- ➢ It is bulky and contains large amount of water.
- ➢ Its specific gravity may be taken as very nearly equal to that of water.
- ➢ In 100 parts of sludge, about 98 % of water and remaining 2 % only the solid matter present in the sludge.
- ➢ In the moisture content of the sludge is reduced to about 70 % to 80 %, the sludge become viscous.
- ➢ If the moisture content is reduced to 10 %, the sludge becomes dry and assumes powder form.
- ➢ The water is so firmly held in the sludge and it requires special treatment for water removal from the sludge.

QUANTITY OF SLUDGE:

- The quantity of sludge, either in bulk or in weight at a particular sewage treatment unit, is calculated by considering the following three factors.
- ✓ Amount of suspended solids in the sewage
- ✓ Settlement in the treatment
- ✓ Moisture content
- The problem with the sludge is its high moisture content.
- In case of raw sludge, moisture content will be 95 % and activated sludge process's sludge, the moisture content is about 99 %.
- Sludge, high in moisture content becomes very bulky, difficult to be subsequently.
- Solid's concentration in raw sludge varies in the range of 1 % to 8 % depending on the waste water treatment.
- Raw sludge is only 4 % to 6 %, raw sludge combined with secondary sludge 3 % to 4 % and waste activated alone 0.5 % to 2 %.
- All the wastes contain volatile solids which are approximately 70 % of the total dry solids.

SLUDGE THICKENING:

- The process of reducing the moisture or water content of the sludge is called sludge thickening.
- The sludge from primary sedimentation tank and sludge from secondary sedimentation units contains 96 % to 99 % of moisture content in its volume.
- Before disposing the sludge, the moisture should be removed in order to reduce the volume of sludge disposal.
- The unit, used for the sludge thickening process and thus to reduce the moisture content of the sludge is called sludge thickeners or sludge concentration units.

PURPOSE OF SLUDGE THICKENING:

- The sludge thickening or dewatering is adopted for reducing the volume of sludge or increasing the solid concentration for the following purposes.

- ✓ To permit increased loading to the sludge digesters.
- ✓ To increase feed solids concentration to vacuum filters.
- ✓ To reduce the cost of transport for heavy volume of disposal.
- ✓ To minimize the land requirement.
- ✓ To save the additional fuel required for incineration method for sewage disposal.
- ➢ There are three types of sludge thickeners:
- ✓ Gravity thickeners
- ✓ Floatation thickeners
- ✓ Centrifugal thickeners.

SLUDGE DIGESTION:

- ✓ Sludge digestion is defined as the process of decomposing the organic matter of sewage sludge under anaerobic conditions of adequate operational control.
- ✓ Sludge deposited in the primary sedimentation tank is called Raw sludge.
- ✓ Sludge deposited in the secondary clarifier is called Secondary sludge.
- ✓ Raw sludge is odourous and contains high putresicible organic matters and highly objectionable.
- ✓ Secondary sludge is also putresicible though less objectionable.

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – III – WATER QUALITY MANAGEMENT– SCIA4002

INTRODUCTION

ROLE OF ENVIRONMENTAL ENGINEER:

- The major task of environmental engineers is to protect public health by preserving and enhancing the environment.
- They are engaged in designing various pollution control equipment and devices, construction, installation, implementation and operation of environmentally-related procedures.
- Environmental engineers optimize the use of natural resources, help to develop renewable energy resources and maximize the use of existing materials.
- Provide technical support in developing and implementing environmental programs in industries.
- Generate environmental reports as per federal and state regulations.
- Stay updated with air, water and waste regulations as defined by state and federal laws.
- Review and recommend improvements to existing environmental programs to reduce environmental damages.
- Oversee waste management and pollution control activities.
- Perform regular site surveys for environmental compliances.
- Assess potential environmental risks and develop mitigation plans.
- Provide assistance and job trainings to team members as needed.
- Analyze root causes of environmental incidents and propose corrective action plans.
- Prepare and maintain environmental documentations for reference purposes.
- Assist in environmental audits and implement audit recommendations.
- Assist in getting and maintaining environmental permits for industries.
- Environmental engineers help identify and develop solutions to environmental problems in order to protect the population from harm or enhance people's quality of life.

- An environmental engineer may assist with a project aimed at improving a recycling process in a nearby municipality, or may work with an organization to monitor levels of air pollution and take necessary action.

WATER SUPPLY

- The organized water supply to Chennai was commenced in 1872 which is the nucleus of the protected surface water supply system now in existence in Chennai.
- Water supply is the provision of water by public utilities, commercial organizations, community endeavors or by individuals, usually via a system of pumps and pipes.

TYPES OF WATER SUPPLY:

Continuous water supply.

Intermittent water supply.

CONTINUOUS WATER SUPPLY:

Continuous system of water supply 24x7 supply is achieved when water is delivered continuously to every consumer of the service 24 hours a day, every day of the year, through a transmission and distribution system that is continuously full and under positive pressure.

So, there is no chance of infiltration i.e, negative pressure cannot occur and as a result the quality of water is better.

As the supply is continuous, so there is more consumption of water and less chances of contamination.

If the supply of water is cut off for half an hour daily, then supply cannot be called as continuous supply.

ADVANTAGES:

In this system water is not stagnant in pipe at any instant & hence fresh water is always available.

Lesser pipe sizes are required.

Fire hazards can be met within time.

DISADVANTAGES:

If there are some minor leakages etc. in the system, great volume of water is wasted because of long duration of flow.

More water is required at the source which is difficult in tropical countries like India, which get rains only during a particular season.

More wastage of water due to lack of civic sense.

INTERMITTENT WATER SUPPLY:

In this case, water is supplied at regular intervals throughout the day.

For example, water may be supplied for a few hours in the morning and few hours in the evening.

As it is not continuous supply so the consumption is less.

Due to negative pressure, the quality of water is not so good compared to the case of continuous supply.

As the water is supplied after intervals, it is called intermittent system.

Domestic storage is not necessary, since there is a continuous supply of water 24X7.

The consumers have to store water for non-supply hours which is likely to get contaminated.

ADVANTAGES:

For older distribution systems having weaker joints and more leakage, restrained supply hours can limit leakage

Reduced pressure also helps lowering leakage

Overall scarcity may sometimes be managed by interrupting the water supply and equally balancing the resources (controversial)

Time is available for repair and maintenance out of supply hours

DISADVANTAGES:

Systems do not operate as designed: components are underused, others are overexploited and damaged.

Inconvenience to consumers, mostly the poor (often, one person per household is devoted to storing the water at supply times)

Pipelines are subjected to vacuum condition after supply hours, which can cause groundwater infiltration into the pipelines with contamination of the supply or pipes deformation.

Frequent contamination requires household-level water treatment, as well as higher doses of residual chlorine by the supplier.

Consumers need to store water between supplies and tend to throw away. This causes water wastage and storage costs.

Frequent wear and tear on valves, water meters malfunction.

More manpower and infrastructures needed.

High capital cost of making the system stronger compared to a continuous water supply system, Often, no immediate supply and pressure in case of fire.

DEVELOPMENT OF PUBLIC WATER SUPPLY

Further water was directly procured from these sources by the persons as per their requirements and there was no public water supply system.

The service reservoirs, besides supplying water at adequate pressures, serve to balance the variations in the public demand of water.

Due to relatively less requirement of water in the early times, which was mainly for domestic purposes, these sources were deemed to be sufficient to meet the requirements of the persons residing in the nearby areas.

NEED FOR PROTECTED WATER SUPPLIES

Source water protection safeguards public health by ensuring the quality and quantity of source water used for drinking-water.

Protecting water sources can reduce health risks associated with hazardous agents, particularly for those agents that cannot be effectively removed by conventional water treatment.

Furthermore, many public water systems draw all or part of their supply from groundwater, so protecting the resource protects the public water supply and impacts treatment costs.

Protecting groundwater will help reduce risks to your water supply.

OBJECTIVES OF WATER SUPPLY SYSTEMS

- To supply safe and wholesome water to the consumers.
- To supply water in adequate quantity.
- To make water available within easy reach of the consumers so as to encourage the general cleanliness.
- A water distribution system consists of a network of pipelines of various sizes with control valves for carrying water to all streets and supplying water to the consumers through the service connections to the properties.

- Water distribution system may be either continuous or intermittent.

QUALITY OF WATER

WHOLESOME WATER:

- ✓ Wholesome water is the water that is safe and potent for drinking to human health.
- ✓ It is cleaned of harmful contaminants, transparent, odourless, harmless and
- ✓ Wholesome water is fit to use for drinking, cooking, food preparation or washing without any potential danger to human health by meeting the requirements free from any disease-causing bacteria.
- ✓ Water which is not chemically pure but does not contain anything harmful to human health.

REQUIREMENTS OF WHOLESOME WATER:

- ✓ It should be free from bacteria's which may cause disease.
- ✓ It should be colourless and sparkling which may be accepted by the public.
- ✓ It should be tasty, odour-free and cool.
- ✓ It should corrode pipes.
- ✓ It should be free from all objectionable matter.
- ✓ It should have dissolved oxygen and free carbonic acid so that it may remain fresh.

PALATABLE WATER:

- ✓ The water which is tasteful for drinking and aesthetically pure is known as palatable water.

POTABLE WATER:

- ✓ The water which has both the characteristics of wholesome water and palatable water is known as potable water.

POLLUTED WATER:

- ✓ The water which consists of undesirable substances which make it unfit for drinking and domestic use is known as polluted water.

CONTAMINATED WATER:

- ✓ The water containing pathogenic organisms is called as contaminated water.

- ✓ The contaminated water is always be polluted but the polluted water may not be contaminated.

IMPURITIES IN WATER

SUSPENDED IMPURITIES:

- ✓ Impurities are dispersion of solid particles that are large enough to be removed by filtration on surface and heavier ones settle down.
- ✓ Suspended impurities which have same specific gravity as that of water, are mixed in the water.
- ✓ Suspended impurities include Clay, silt, Algae, protozoa, Fungi, Organic and Inorganic matters and mineral matter etc.,
- ✓ These all impurities are macroscopic and cause turbidity in the water.
- ✓ The concentration of suspended matter in water is measured by its turbidity.
- ✓ The size of suspended impurities ranges from $0 - 10^{-3}$ mm.

COLLOIDAL IMPURITIES:

- ✓ It is very finely divided dispersion of particles in water.
- ✓ These particles are so small that these cannot be removed by ordinary filters and are not visible to the naked eye.
- ✓ As a matter of fact, all the colloidal impurities are electrically charged and remain in continuous motion.
- ✓ The electric charge is due to the presence of absorbed ions on the surface of the solid.
- ✓ These colloidal impurities are generally associated with organic matter containing bacterias and are the chief source of epidemics.
- ✓ Most of the colour of the water is due to colloidal impurities.
- ✓ The size of colloidal particles is between (1 = 1 micron = 0.001mm) to 1 = 1 milli micron = 0.000001mm) or (10^{-3} mm to 10^{-6} mm)

DISSOLVED IMPURITIES:

- ✓ Some impurities are dissolved in water when it moves over the rocks, soil etc.,
- ✓ Solids, liquids and gases are dissolved in natural waters.

- ✓ These dissolved impurities may contain organic compounds, inorganic salts and gases etc.
- ✓ The concentration of total dissolved solids is usually expressed in p.p.m and is obtained by weighing the residue after evaporation of the water sample from a filtered sample.
- ✓ Dissolved impurities include Calcium and magnesium, Sodium, Metal, Gases.
- ✓ Suspended solids are substances that are not completely soluble in water and are present as particles.
- ✓ These particles usually impart a visible turbidity to the water. Dissolved and suspended solids are present in most surface waters.

CHARACTERISTICS OF WATER

PHYSICAL CHARACTERISTICS:

- ✓ Temperature
- ✓ Colour
- ✓ Turbidity
- ✓ Taste and Odours
- ✓ Specific conductivity of water

TEMPERATURE:

- ✓ The temperature of water is measured by means of ordinary thermometers.
- ✓ The temperature of surface water is generally same to the atmospheric temperature, while that of ground water may be more or less than atmospheric temperature.
- ✓ The most desirable temperature for public supply is between 4.4 °C to 10 °C.
- ✓ Temperature above 28 °C are undesirable and above 35 °C are unfit for public supply, because it is NOT PALATABLE(NOT ACCECTABLE TO TASTE).

COLOUR:

- ✓ The colour of water is usually due to presence of organic matter, but sometimes it is also due to mineral and dissolved organic and inorganic impurities.

- ✓ The colour of water is compared with standard colour solution.
- ✓ The permissible colour for domestic water is 20 ppm on platinum cobalt scale.
- ✓ The colour in water is not harmful but it is objectionable.

TURBIDITY:

- ✓ It is caused due to presence of suspended and colloidal matter in the water.
- ✓ The character and amount of turbidity depends on the type of soil over which the water has moved ground waters are less turbid than the surface water
- ✓ Turbidity is a measure of resistance of water to the passage of light through it.
- ✓ Turbidity is expressed as NTU (Nephelometric Turbidity Units) or PPM (parts per million) or Milligrams per litre (mg/l).

TASTE AND ODOURS:

- ✓ Taste and odours in water may be due to the presence of dead or alive micro-organisms, dissolved gases such as hydrogen sulphide, methane, carbon dioxide or oxygen combined with organic matter, mineral substance such as sodium chloride, iron compounds, and carbonate and sulphates of other substances.
- ✓ The test of these is done by sense of smell and taste because these are present in such small proportions that it is difficult to detect them by chemical analysis.
- ✓ The odour of water also changes with temperature.
- ✓ The odour may be classified as fishy, mouldy, sweetish, vegetable, greasy etc.
- ✓ The odour of both cold and hot water should be determined.
- ✓ The water having bad smell or odour is objectionable and should not be supplied to the public.
- ✓ The intensities of the odours are measured in terms of threshold number.

SPECIFIC CONDUCTIVITY OF WATER:

- ✓ The total amount of dissolved salts present in water can be easily estimated by measuring the specific conductivity of water.

- ✓ The specific conductivity of water is determined by means of portable dionic water tester and it expressed in micro-mohs per cm at 25° C (Mho is the unit of conductivity).
- ✓ The specific conductivity of water in micro-mhos per cm at 25° C is multiplied by a coefficient (generally 0.65) so as to directly obtain the dissolved salt content in mg/litre or ppm.
- ✓ The exact value of this coefficient depends upon the type of salt present in water.

CHEMICAL CHARACTERISTICS:

- ✓ pH-value
- ✓ Total Solids
- ✓ Hardness
- ✓ Chlorides
- ✓ Dissolved gases
- ✓ Nitrogen
- ✓ Iron and manganese
- ✓ Lead and arsenic
- ✓ Metals and chemical substance
- ✓ Acidity
- ✓ Alkalinity
- ✓ Sulphates

PH-VALUE:

- ✓ Depending upon the nature of dissolved salts and minerals, the water found in natural sources may be acidic or alkaline.
- ✓ The acidity or alkalinity is usually measured in p.p.m. of the dissolved salts and is expressed in terms of equivalent weight of calcium carbonate.
- ✓ Denotes the concentration of hydrogen ions in the water and it is a measure of acidity or alkalinity of a substance.
- ✓ $pH = - \log_{10}[H +]$ (or) $1 / \log_{10}[H +]$

- ✓ Depending upon the nature of dissolved salts and minerals, the PH value ranges from 0 to 14.
- ✓ For pure water, pH value is 7 and 0 to 7 acidic and 7 to 14 alkaline ranges.
- ✓ For public water supply pH value may be 6.5 to 8.5.
- ✓ The lower value may cause tuberculation and corrosion, whereas high value may produce incrustation, sediment deposits and other bad effects.
- ✓ pH value of water is generally determined by pH papers or by using pH meter.
- ✓ Its knowledge is also helpful in controlling softening and coagulation processes in water treatment.
- ✓ There are two methods of determine pH value of water:
- ✓ Colourimetric method,
- ✓ Electrometric method

TOTAL SOLIDS:

- ✓ Includes the solids in suspension, colloidal and in dissolved form.
- ✓ The quantity of suspended solids is determined by filtering the sample of water through fine filter, drying and weighing.
- ✓ The quantity of dissolved and colloidal solids is determined by evaporating the filtered water obtained from the suspended solid test and weighing the residue.
- ✓ The total solids in a water sample can be directly determined by evaporating the filtered water obtained from the suspended solid test and weighing the residue.
- ✓ The total solids in a water sample can be directly determined by evaporating the water and weighing the residue of the residue of total solids is fused in a muffle furnace the organic solids will decompose whereas only inorganic solids will remain.

HARDNESS:

- ✓ It is a property of water, which prevents the lathering of the soap.
- ✓ It is caused due to the presence of carbonates and sulphates of calcium and magnesium in the water.

- ✓ Sometimes the presence of chlorides and nitrates of calcium and magnesium also cause hardness in the water.
- ✓ Hardness is of two types.
- ✓ Temporary hardness:
- ✓ It is caused due to the presence of carbonates and sulphates of calcium and magnesium. It is removed by boiling.
- ✓ Permanent hardness:
- ✓ It is caused due to the presence of chlorides and nitrates of calcium and magnesium. It is removed by zeolite method.
- ✓ Hardness is usually expressed in mg/litre or ppm. of calcium carbonate in water.
- ✓ Hardness of water is determined by EDTA method.
- ✓ For potable water hardness ranges from 5 to 8 degrees.

CHLORIDE CONTENT:

- ✓ Sodium chloride is the main substance in chloride water.
- ✓ The natural water near the mines and sea has dissolve sodium chloride.
- ✓ Similarly, the presence of chlorides may be due to the mixing of saline water and sewage in the water.
- ✓ Excess of chlorides is dangerous and unfit for use.
- ✓ The chlorides can be reduced by diluting the water.
- ✓ Chlorides above 250 p.p.m. are not permissible in water.
- ✓ Chlorides are estimated by titration the water with standard silver nitrate solution using potassium chromate as indicator.
- ✓ In this titration process reddish colours will be formed if chlorides are present.

CHLORINE:

- ✓ Dissolved free chlorine is never found in natural waters.
- ✓ It is present in the treated water resulting from disinfection with chlorine.
- ✓ The chlorine remains as residual in treated water for the sake of safety against pathogenic bacteria.

- ✓ Residual chlorine determined by the starch iodide test.
- ✓ The residual chlorine should remain between 0.5 p.p.m. to 0.2 p.p.m. in the water so that it remains safe against pathogenic bacteria.

NITROGEN CONTENT:

- ✓ The presence of nitrogen in the water indicates the presence of organic matters in the water. The nitrogen may be present in the water may be in one or more of the following forms.
- ✓ Nitrites
- ✓ Nitrates
- ✓ Free ammonia
- ✓ Albuminoid nitrogen.
- ✓ Excess presence of nitrogen will cause "MATHEMOGLOBINEMIA" disease to the children.

NITRITES:

- ✓ The presence of nitrites in the water due to partly oxidized organic matters, is very dangerous.
- ✓ Therefore, in no case nitrites should be allowed in the water, their presence must be nil.
- ✓ The nitrites are rapidly and easily converted to nitrates by the full oxidation of the organic matters.
- ✓ The presence of nitrates is not so harmful.
- ✓ But in no case its quantity should increase 45 p.p.m., because excess presence of nitrate will cause "mathemoglobinemia" disease to the children.
- ✓ Nitrite in water is either due to oxidation of ammonium compounds or due to reduction of nitrate.
- ✓ As an intermediate stage in the nitrogen cycle, it is unstable.
- ✓ A usual concentration in natural water is in the range of some tenths of mg/L.
- ✓ Higher concentrations are present in industrial wastes, sewage and in biologically purified effluents and in polluted streams.
- ✓ Very high nitrite levels are usually associated with water of unsatisfactory microbiological activity.

- ✓ The presence of nitrites or nitrate can be determined by colour matching methods.
- ✓ For determining the presence of nitrites, the colour is obtained by adding sulphonic acid and napthamine.
- ✓ For testing presence of nitrates, the colour is obtained if phenol-di-sulphonic acid and potassium hydroxide are added.
- ✓ The colours so developed are compared with standard colours to ascertain the p.p.m. contents.

NITRATE:

- ✓ Nitrate constitutes the final stage in the oxidation of nitrogen compounds, and normally reaches important concentrations in the final stages of biological oxidation.
- ✓ The nitrate contained in pure well water derived from an extensive catchment is largely the result of biological activity in the surface layers of the soil, enhanced by cultivation and the application of manures.
- ✓ When the nitrate in in the excessive amounts, it contributes to the illness known as infant methemoglobinemia.
- ✓ Nitrate is measured either by reduction to ammonia or by matching the colours produced with phenol-di-sulphonic acid.

FREE AMMONIA:

- ✓ Free ammonia is obtained from the decomposition of organic matters in the beginning.
- ✓ Therefore, if free ammonia is present in the water, it will indicate that the decomposition of the organic matters has started recently.
- ✓ The presence of nitrates indicates partly decomposition of organic matters. Whereas the presence of nitrates indicates fully oxidized organic matters.
- ✓ The presence of free ammonia in water should not exceed 0.15 p.p.m. the presence of free ammonia can be easily determined by boiling the water and measuring the ammonia gas obtained.
- ✓ Ammonia is produced by the microbiological degradation of organic nitrogenous matter.
- ✓ It appears, therefore, in many ground waters as well as surface waters.

- ✓ Concentrations of ammonia above a certain level in water polluted either due to sewage or industrial waste is toxic to fish.
- ✓ The proportions of the two forms of ammonia nitrogen in surface water depend on pH.
- ✓ For accurate results, it is generally preferable to distill off ammonia from the sample, and absorb in boric acid.
- ✓ It is then determined either by titration or colorimetrically using Nessler reagent.

ALBUMINOID NITROGEN:

- ✓ The presence of albuminoid nitrogen in water indicates the pollution of water.
- ✓ Its measurement is done by adding strong alkaline solution of potassium permanganate to the already boiled water.
- ✓ In no case the quantity of albuminoid nitrogen should exceed 0.3 p.p.m.

DISSOLVED GASES:

- ✓ Oxygen and carbon di-oxide are the gases mostly found in the natural water.
- ✓ The surface water contains large amount of dissolved oxygen because they absorb it from the atmosphere.
- ✓ Algae and other tiny plant life of water also give oxygen to the water.
- ✓ The presence of oxygen in the water in dissolved form keeps it fresh and sparkling.
- ✓ But more quantity of oxygen causes corrosion to the pipe's material. Water absorbs carbon-dioxide from the atmosphere.
- ✓ If water comes across calcium and magnesium salts, carbon-dioxide reacts with the salts and converts them into bicarbonates, causes hardness in the water.
- ✓ The presence of carbon-dioxide is easily determined by adding lime solution to water gives milky white colour.

IRON & MANGANESE:

- ✓ These are generally found in ground water.

- ✓ If these are present less than 0.3 p.p.m., it is not objectionable, but if exceeds 0.3 p.p.m. the water is not suitable for domestic, bleaching, dyeing and laundering purposes.
- ✓ The presence of iron and manganese in water makes brownish red colour in it, leads to the growth of microorganism and corrodes the water pipes.
- ✓ Iron and manganese also cause taste and odour in the water.
- ✓ The quantity of iron and manganese is determined by colorimetric methods.

LEAD & ARSENIC:

- ✓ These are not usually found in natural waters.
- ✓ But sometimes lead is mixed up in water from lead pipes or from tanks lined with lead paint when water moves through them.
- ✓ These are poisonous and dangerous to the health of the public.
- ✓ The presence of lead and arsenic is detected by means of chemical tests for it.

METALS & OTHER CHEMICAL SUBSTANCES:

- ✓ Water contains various types of minerals or metals such as iron, manganese, copper, lead, barium, cadmium, selenium, fluoride, arsenic etc.
- ✓ The concentration of iron and manganese should not be allowed more than 0.3 p.p.m.
- ✓ Otherwise, they will cause discolouration of clothes during washing.
- ✓ They may also cause incrustation in water mains due to deposition of ferric hydroxide and manganese oxide.
- ✓ As barium and lea are very toxic, a low p.p.m. of these are allowed.
- ✓ Arsenic, selenium is poisonous and may cause fatality, therefore they must be removed totally.
- ✓ Human lungs are affected by presence of high quality of copper in the water.
- ✓ A laxative effect is caused in the human body due to presence of sulphates in the water.
- ✓ Fewer cavities in the teeth will be formed due to excessive presence of fluoride in water more than 1 p.p.m.

BIOLOGICAL CHARACTERISTICS:

- ✓ Total count of bacteria
- ✓ Bacteria coli (B-coli) test
- ✓ Total count of bacteria:
- ✓ Bacterial examination of water is very important, since it indicates the degree of pollution.
- ✓ Water polluted by sewage contain one or more species of disease producing pathogenic bacteria.
- ✓ Pathogenic organisms cause water borne diseases, and many non-pathogenic bacteria such as E.Coli, a member of coliform group, also live in the intestinal tract of human beings.
- ✓ Coliform itself is not a harmful group but it has more resistance to adverse condition than any other group.
- ✓ So, if it is ensured to minimize the number of coliforms, the harmful species will be very less.
- ✓ So, coliform group serves as indicator of contamination of water with sewage and presence of pathogens.
- ✓ The methods to estimate the bacterial quality of water are:
- ✓ Standard Plate Count Test
- ✓ Most Probable Number
- ✓ Membrane Filter Technique
- ✓ Bacteria coli (B-coli) test:
- ✓ Sometimes this is also called as E–coli test.
- ✓ There are two tests for B-coli, first is presumptive and second confirmative.
- ✓ In the presumptive test, definite amount of diluted sample of the water in standard fermentation tubes containing lactose broth as culture medium is kept in incubator at 37 C for 24 to 48 hours.
- ✓ If some gas is produced in the fermentation tube, it indicates the presence of B-coli.

- ✓ In the confirmation test some sample from the presumptive tube is taken and placed in another fermentation tube containing "brilliant green lactose bile" as culture medium.
- ✓ It is again kept in incubator at 37 C for 48 hours, if there is formation of gas in the tube, it confirms the presence of B-coli and the water is unsafe for use.
- ✓ Nowadays a new technique of finding out the B-coli is developed which is called 'Membrane Filter Technique".
- ✓ This is a very simple method.
- ✓ In this method the sample of water is filtered through a sterilized membrane of special design due to which all the bacteria are retained on the membrane.
- ✓ The member is then put in contact of culture medium-M-Endo's medium in the incubator for 24 hours at 37 C.
- ✓ The membrane after incubating is taken out and the colonies of bacteria are counted by means of microscope.
- ✓ This method is known as 'membrane filter technique".

MEMBRANE FILTER TECHNIQUE:

- ✓ Now a days a new technique of finding out the B-coli.
- ✓ Alternative to MPN.
- ✓ Membrane contains microscopic pores which are capable of retaining bacteria.
- ✓ Water is filtered through the membrane and it is then incubated for a period of 20 hours along with nutrients.
- ✓ The colonies of bacteria can then be counted.

MOST PROBABLE NUMBER:

- ✓ It is the number which represents the bacterial density which is most likely to be present.

COLIFORM INDEX:

- ✓ Coliforms are the rod, shaped, non-pathogenic bacteria whose presence or absence in water indicates the presence or absence of fecal pollution.

- ✓ The total coliform group consists of members whose normal habitat is the – (lower portion of intestines) of humans and warm and cold-blooded animals and soil.
- ✓ Some members which are not found in soil and vegetation constitute about 96% of all the coliforms of human fecal.
- ✓ Such members are called fecal coliforms and recently named by WHO
- ✓ The total coliform group is widely used as a indicator organism of choice for drinking water.
- ✓ Escherichia coli (E-Coli) is the predominant member of the fecal coliform group.
- ✓ Used to measure coliform bacteria present in water sample.
- ✓ It is defined as the reciprocal of the smallest quantity of sample which would give a positive B-coli test.
- ✓ Should be preferably less than 3 and should not exceed 10.
- ✓ But due to the development of the 'Membrane Filter technique" the MPN or C.I methods are not used.
- ✓ For the drinkable water it is necessary that it must be free from pathogenic bacteria.

WATER QUALITY STANDARDS:

- ✓ The Water Quality Standards Regulation requires states, territories and authorized tribes to specify goals and expectations for how each water body is used.
- ✓ Typical designated uses include:
- ✓ Protection and propagation of fish, shellfish and wildlife
- ✓ Recreation
- ✓ Public drinking water supply
- ✓ Agricultural, industrial, navigational and other purposes.

INDICATORS OF WATER QUALITY:

- ✓ They include dissolved oxygen, pH, temperature, salinity and nutrients (nitrogen and phosphorus).

- ✓ They also include measures of toxicants such as insecticides, herbicides and metals.

IMPORTANCE OF WATER QUALITY STANDARD:

- ✓ Water quality standards specify the conditions water must meet to protect those specific uses.
- ✓ Measuring lakes and rivers against water quality standards shows which bodies of water need restoration and protection, and dictates how we set limits on pollutant discharges from public and private facilities.

SUSTAINABLE DEVELOPMENT:

- ✓ Sustainable development of water resources refers to reducing the usage of water and recycling of waste water for different purposes such as cleaning, manufacturing, and agricultural irrigation in such a way that water demands of future generations are not hampered.
- ✓ Water is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself.
- ✓ It is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations.

WAYS TO CONSERVE WATER FOR A SUSTAINABLE LIVING:

- ✓ Turn off the tap when it's not in use.
- ✓ Soak your dishes in warm water first.
- ✓ Run your dishwasher and laundry only when its full.
- ✓ Cut those long showers short.
- ✓ Use energy-efficient, water-saving devices.
- ✓ Use a water softener to tackle hard water problems.
- ✓ Fix plumbing leaks.
- ✓ Go easy on your sprinklers and gardening hose.

TURN OFF THE TAP WHEN IT'S NOT IN USE:

- ✓ Keeping the water running while brushing your teeth or shaving, wastes about 4-5 gallons of water on average.

SOAK YOUR DISHES IN WARM WATER FIRST:

- ✓ Soaking your dishes is more effective than scraping them in running water.

- ✓ You will save water and a whole lot of effort.

RUN YOUR DISHWASHER AND LAUNDRY ONLY WHEN ITS FULL:

- ✓ Your dishwasher and washing machine can each use a whopping 10-15 gallons of water per cycle.
- ✓ For laundry machines, an older agitator model uses up to 40 gallons of water, and a front-loader uses about 7 gallons.
- ✓ So, you will get better value for your money and save water by doing fewer, fuller loads.

CUT THOSE LONG SHOWERS SHORT:

- ✓ There's nothing like a long, hot shower to fire up your grey cells. Or a relaxed bath at the end of a hard day.

USE ENERGY-EFFICIENT, WATER-SAVING DEVICES:

- ✓ If long showers are your thing, you could install low-flow shower heads instead.
- ✓ They tend to have lesser water pressure and therefore, lesser water flow, while still offering a satisfying shower.
- ✓ You could also opt for Ultra-low flush (ULF) toilets. They use less water per flush but are just as effective.

FIX PLUMBING LEAKS:

- ✓ If you've done everything, but your water bills are still high, leaky plumbing could be the problem.
- ✓ Keep a close eye on your utility bills.
- ✓ And get your plumbing checked and fixed to reduce water wastage.

GO EASY ON YOUR SPRINKLERS AND GARDENING HOSE:

- ✓ While watering the lawn, ensure your sprinkler system is effectively watering just your lawn.

USE DRIP IRRIGATION TO WATER YOUR PLANTS:

- ✓ Garden hoses and sprinklers can overwater your plants.
- ✓ Much of this water could also be lost through evaporation and runoff.
- ✓ So, if you have a small garden or few plants, try drip irrigation.

- ✓ That way, your plants will have enough water consistently.

REUSE WATER FOR LANDSCAPE GARDENS:

- ✓ Instead of washing your fruits and vegetables in running water, rinse them in a bowl of water.
- ✓ This water is not ideal for drinking or personal use, but you can use it to water your plants.
- ✓ The EPA explains how to recycle and reuse water sustainably.
- ✓ With small steps, we can make a big difference to ensure our planet stays healthy and habitable.

RAIN WATER HARVESTING:

- ✓ Rainwater harvesting (RWH) is the collection and storage of rain, rather than allowing it to run off.
- ✓ The harvested water can also be committed to longer-term storage or groundwater recharge.
- ✓ Rainwater harvesting helps utilities reduce peak demands during summer months, saving treated water for more important and appropriate water uses.
- ✓ While rainwater can be a perfect primary water source for many uses and situations, it is also a great backup water supply for emergency situations.

Figure No.1

- ✓ The main purpose of the rainwater harvesting is to use the locally available rainwater to meet water requirements throughout the year without the need of huge capital expenditure.
- ✓ This would facilitate the availability of uncontaminated water for domestic, industrial, and irrigation needs.
- ✓ Rainwater harvesting is a sustainable process that helps in preserving water for future needs.
- ✓ Water scarcity is a major concern in today's scenario.
- ✓ The process of rainwater harvesting is a good way to conserve water.

WATER CONSERVATION BENEFITS OF RAINWATER HARVESTING:

- ➢ The rainwater that falls on your roof and property is essentially free.
- ➢ All it takes is a method to harvest it into a tank or cistern for later use.
- ➢ Rainwater harvesting can be a great educational tool to get people to recognize their individual or household water usage.
- ➢ This can get them to start conserving water in other areas around their home.
- ➢ For communities that depend on imported water to supply their needs, collecting rainwater that falls naturally in the community can reduce the need for imported water.
- ➢ Rainwater harvesting helps utilities reduce peak demands during summer months, saving treated water for more important and appropriate water uses.

ENVIRONMENTAL BENEFITS OF RAINWATER HARVESTING:

- ➢ Rainwater harvesting can reduce stormwater runoff from a property.
- ➢ The elimination of runoff can reduce contamination of surface water with pesticides, sediment, metals, and fertilizers.
- ➢ By reducing stormwater runoff, rainwater harvesting can reduce a storm’s peak flow volume and velocity in local creeks, streams, and rivers, thereby reducing the potential for streambank erosion.
- ➢ Rainwater harvesting systems can be employed as simple and effective methods to meet a municipality’s stormwater management program requirements of individual properties.
- ➢ It is an excellent source of water for plants and landscape irrigation since it has no chemicals such as fluoride and chloramines (chlorine).

- Rainwater harvesting systems can be employed as simple and effective methods to meet a municipality's stormwater management program requirements of individual properties.
- It is an excellent source of water for plants and landscape irrigation since it has no chemicals such as fluoride and chloramines (chlorine).

ARTIFICIAL RECHARGE TECHNIQUES:

- Artificial subsurface groundwater recharge refers to recharge techniques (generally recharging wells) that release the water below the ground (as opposed to surface groundwater recharge where water percolates through the soil before entering the groundwater aquifer).
- Artificial recharge is the process of spreading or impounding water on the land to increase the infiltration through the soil and percolation to the aquifer or of injecting water by wells directly into the aquifer.
- Surface infiltration systems can be used to recharge unconfined aquifers only.
- To ensure the effective and efficient operation of an artificial recharge system, a thorough and detailed hydro geological study must be conducted before selecting the site and recharge method.
- In particular, the following basic factors should be considered (UNEP 1998):

- ✓ Location of geologic and hydraulic boundaries
- ✓ Transmissivity of the overlying material
- ✓ Depth of the aquifer and lithology
- ✓ Storage capacity
- ✓ Porosity
- ✓ Hydraulic conductivity
- ✓ Natural in- and outflow of water to/from the aquifer
- ✓ Availability of land
- ✓ Surrounding land use and topography
- ✓ Quality and quantity of water to be recharged
- ✓ Economic and legal aspects concerning the recharge
- ✓ Degree of public acceptance

FACTORS AFFECTING ARTIFICIAL RECHARGE:

- ✓ The extent of groundwater recharge by a wetland is dependent upon soil, vegetation, site, perimeter to volume ratio, and water table gradient.
- ✓ Groundwater recharge occurs through mineral soils found primarily around the edges of wetlands.
- ✓ The soil under most wetlands is relatively impermeable.

TECHNIQUES USED FOR GROUNDWATER RECHARGE:

- ✓ For example, groundwater can be artificially recharged by redirecting water across the land surface through canals, infiltration basins, or ponds; adding irrigation furrows or sprinkler systems; or simply injecting water directly into the subsurface through injection wells.

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – IV – HEALTH IMPACTS – SCIA4002

INTRODUCTION

WATER POLLUTION

- Water pollution is the pollution of bodies of water, such as lakes, rivers, seas, the oceans, as well as groundwater.
- It occurs when pollutants reach these bodies of water, without treatment.
- Water pollution is a problem for the species and ecosystems there. It affects plants and organisms living in the water.
- Water pollution is the release of substances into bodies of water that makes water unsafe for human use and disrupts aquatic ecosystems.
- Water pollution occurs when harmful substances often chemicals or microorganisms contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.
- Water pollution occurs when harmful substances often chemicals or microorganisms contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.
- Water pollution is a change caused in the chemical, physical or biological properties of the water that has the capacity of hurting the living organism.
- In simple terms, water pollution is the contamination of water bodies like lakes, rivers, oceans, aquifers, groundwater, or the sea.
- The pollution is usually caused due to human interference.

TWO TYPES OF WATER POLLUTION:

- ✓ Organic pollution due to microorganisms - bacteria and viruses - present in the water, generated by excrement, animal and vegetable waste.
- ✓ Chemical pollution generated by the nitrates and phosphates of pesticides, human and animal drugs, household products, heavy metals, acids and hydrocarbons used in industries.

CAUSES OF WATER POLLUTION

SEWAGE OR WASTEWATER:

- ✓ The waste from households, factories, or agricultural land gets discharged into rivers or lakes.
- ✓ This waste can either be in the form of liquid waste, garbage, or sewage.
- ✓ The harmful chemicals oozing out of this waste can damage aquatic life.

DUMPING:

- ✓ Most water bodies get converted into dumping grounds by nearby localities.

- ✓ And this causes a huge problem because the dump contains everything from plastic, aluminum to glass, Styrofoam, etc.
- ✓ And since all the waste takes different time to degrade in the water, they tend to harm the aquatic life until degraded.

OIL POLLUTION:

- ✓ One of the worst types of water pollution is oil pollution.
- ✓ This is because the oil spills from tankers and ships tend to create a thick layer above the water in seas or oceans.
- ✓ And since oil doesn't dissolve, the sludge stays forever.

ACID RAIN:

- ✓ Even though acid rain may seem like a natural problem but it is wise to note that Acid rains are caused due to acidic particles in the contaminated air.
- ✓ These particles in the atmosphere get mixed with water vapor and result in acid rains.

INDUSTRIAL WASTE:

- ✓ Industrial waste is filled with lead, asbestos, petrochemicals, and even mercury.
- ✓ All of these chemicals are highly hazardous for both humans and aquatic life.
- ✓ But many industries tend to discharge the waste into major water bodies like rivers and lakes around living localities, thus, contaminating the fresh water.

EFFECTS OF WATER POLLUTION

- ➢ Pollution of water affects both humans and aquatic life.
- ➢ Most water sources close to cities and urban centres are polluted by garbage and dumping of chemicals, legally or illegally.

EFFECTS ON HUMAN BEINGS:

- ✓ Adding contaminants to water bodies has affected the human family in several ways.
- ✓ According to a 2017 WHO report, 2.1 billion people do not have access to safe water.
- ✓ In 2019, it stated that 785 million people lack access to essential drinking water.
- ✓ One of the main effects of this is diseases.
- ✓ World Health Organization notes that there are about 120,000 cholera-related deaths annually.

DEATH OF AQUATIC LIFE:

- ✓ Animals and plants that depend on water for life are the most affected by polluted water.
- ✓ Aquatic life is destroyed due to the non-biodegradable pesticides and chemicals.

DESTRUCTION OF ECOSYSTEMS:

- ✓ The introduction or elimination of certain microorganisms distorts the ecosystem.
- ✓ Nutrient pollution, for example, leads to an increase in algae, which depletes the water of oxygen, thereby leading to the death of fish and other aquatic life.
- ✓ Ecosystems are extremely dynamic and respond to even small changes in the environment.
- ✓ Destroys life in the water-based ecosystem which is polluted which in turn disrupts natural food chain.
- ✓ Water pollution affects the microbial population.
- ✓ There is a steep increase in the BOD levels of water.
- ✓ The effect of water pollution can have a huge impact on the food chain.

FOOD CHAIN DISRUPTION:

- ✓ Pollution disrupts the food chain by moving the toxins from one level in the chain to higher levels.
- ✓ Microscopic pollution of a body of water as big as the Pacific Ocean might seem negligible, but tiny microplastics, chemicals, heavy metals and other contaminants can be ingested by microorganisms and interfere with their inner organs.
- ✓ These are then consumed by larger animals and so pollution gradually works it way up the food chain.
- ✓ At some point, it's feasible for the contaminants to wipe out a link altogether, or else reach the very top of the pyramid by compromising human health.

DISEASES:

- ✓ In humans, drinking or consuming polluted water in any way has many disastrous effects on our health.
- ✓ It causes typhoid, cholera, hepatitis and various other diseases.
- ✓ According to the UN, every year, approximately 297,000 children under five die from diseases linked to poor sanitation, poor hygiene, or unsafe drinking water.
- ✓ Humans are affected by pollution and can contract diseases such as hepatitis through faecal matter in water sources.
- ✓ Poor drinking water treatment and unfit water can always cause an outbreak of infectious diseases such as cholera, etc.

ENVIRONMENTAL EFFECTS OF WATER POLLUTION

- ➢ Firstly, the disappearance of biodiversity and aquatic ecosystems.
- ➢ Also, humans are harmed by the alteration in the food chain and by contracting illnesses when drinking or using contaminated water.

- When particles like sulfur dioxide get high into the air they can combine with rain to produce acid rain.
- Acid rain can turn lakes acidic, killing fishes and other animals.
- Water pollution can have disastrous effects on the environment.
- Small fishes absorb pollutants, such as chemicals, into their bodies.
- Pollution may muddy landscapes, poison soils and waterways, or kill plants and animals.
- Acid rain can turn lakes acidic, killing fishes and other animals.
- Water pollution can have disastrous effects on the environment.
- Sometimes pollution affects the entire food chain.
- Harm to any of these organisms can create a chain effect, imperiling entire aquatic environments.
- When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water.
- Human health is affected by the direct damage of plants and animal nutrition.
- Water pollutants are killing sea weeds, mollusks, marine birds, fishes, crustaceans and other sea organisms that serve as food for human.
- Insecticides like DDT concentration is increasing along the food chain.

WAYS TO PREVENT WATER POLLUTION

- Pick up litter and throw it away in a garbage can.
- Blow or sweep fertilizer back onto the grass if it gets onto paved areas.
- Mulch or compost grass or yard waste.
- Wash your car or outdoor equipment where it can flow to a gravel or grassed area instead of a street.
- Don't pour your motor oil down the storm drain.
- DO NOT pour fat from cooking or any other type of fat, oil, or grease down the sink.
- DO NOT dispose of household chemicals or cleaning agents down the sink or toilet.
- DO NOT flush pills, liquid or powder medications or drugs down the toilet.
- Avoid using the toilet as a wastebasket.
- Avoid using a garbage disposal.

CATEGORIES OF WATER POLLUTION

GROUNDWATER:

- ✓ For some folks in rural areas, it's their only freshwater source.
- ✓ Groundwater gets polluted when contaminants from pesticides and fertilizers to waste leached from landfills and septic systems make their way into an aquifer, rendering it unsafe for human use.
- ✓ Ridding groundwater of contaminants can be difficult to impossible, as well as costly.
- ✓ Once polluted, an aquifer may be unusable for decades, or even thousands of years.
- ✓ Groundwater can also spread contamination far from the original polluting source as it seeps into streams, lakes, and oceans.

SURFACE WATER:

- ✓ Nutrient pollution, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources.
- ✓ While plants and animals need these nutrients to grow, they have become a major pollutant due to farm waste and fertilizer runoff.
- ✓ Municipal and industrial waste discharges contribute their fair share of toxins as well.

OCEAN WATER:

- ✓ Eighty percent of ocean pollution (also called marine pollution) originates on land whether along the coast or far inland.
- ✓ Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into our bays and estuaries; from there they travel out to sea.
- ✓ Meanwhile, marine debris particularly plastic is blown in by the wind or washed in via storm drains and sewers.
- ✓ Our seas are also sometimes spoiled by oil spills.

POINT SOURCE:

- ✓ When contamination originates from a single source, it's called point source pollution.
- ✓ Examples include wastewater (also called effluent) discharged legally or illegally by a manufacturer, oil refinery, or wastewater treatment facility, as well as contamination from leaking septic systems, chemical and oil spills, and illegal dumping.
- ✓ The EPA regulates point source pollution by establishing limits on what can be discharged by a facility directly into a body of water.
- ✓ While point source pollution originates from a specific place, it can affect miles of waterways and ocean.

NONPOINT SOURCE:

- ✓ Nonpoint source pollution is contamination derived from diffuse sources.
- ✓ These may include agricultural or stormwater runoff or debris blown into waterways from land.

SEWAGE AND WASTEWATER:

- ✓ Used water is wastewater.
- ✓ It comes from our sinks, showers, and toilets (think sewage) and from commercial, industrial, and agricultural activities (think metals, solvents, and toxic sludge).
- ✓ The term also includes stormwater runoff, which occurs when rainfall carries road salts, oil, grease, chemicals, and debris from impermeable surfaces into our waterways.

OIL POLLUTION:

- ✓ Big spills may dominate headlines, but consumers account for the vast majority of oil pollution in our seas, including oil and gasoline that drips from millions of cars and trucks every day.
- ✓ Moreover, nearly half of the estimated 1 million tons of oil that makes its way into marine environments each year comes not from tanker spills but from land-based sources such as factories, farms, and cities.
- ✓ At sea, tanker spills account for about 10 percent of the oil in waters around the world, while regular operations of the shipping industry through both legal and illegal discharge contribute about one-third.
- ✓ Oil is also naturally released from under the ocean floor through fractures known as seeps.

RADIOACTIVE SUBSTANCES:

- ✓ Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment.
- ✓ It's generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and medicine.
- ✓ Radioactive waste can persist in the environment for thousands of years, making disposal a major challenge.
- ✓ Accidentally released or improperly disposed of contaminants threaten groundwater, surface water, and marine resources.

CHEMICALS IN DRINKING WATER

- ➢ Examples of chemical contaminants include nitrogen, bleach, salts, pesticides, metals, toxins produced by bacteria, and human or animal drugs.

- Biological contaminants are organisms in water.
- They are also referred to as microbes or microbiological contaminants.
- The most common drinking water contaminants are microorganisms, nitrate, and arsenic. Water quality monitoring has improved over the past five years.
- Bacteria, viruses, and protozoa (such as Giardia lamblia and Cryptosporidium) are drinking water contaminants that can rapidly cause widespread and serious illnesses.

THE FIVE MOST COMMON CONTAMINANTS FOUND IN DRINKING WATER:

- ✓ Nitrates.
- ✓ Arsenic.
- ✓ Microorganisms, Bacteria, and Viruses.
- ✓ Aluminum.
- ✓ Fluoride.

CONTAMINANTS IN TAP WATER:

- ✓ Lead - Lead is a toxic metal that can cause damage to health even at low doses.
- ✓ Chlorine.
- ✓ Chloramines.
- ✓ Mercury.
- ✓ VOCs.
- ✓ Pharmaceuticals.
- ✓ Herbicides.
- ✓ Pesticides.

CONTAMINANTS IN WELL WATER:

- ✓ Heavy metals include arsenic, lead, copper, chromium, selenium and more.
- ✓ Heavy metals can contaminate private wells through groundwater movement and surface water seepage and run-off.
- ✓ People that consume high levels of heavy metals risk acute and chronic toxicity, liver, kidney, and intestinal damage, anemia, and cancer.

COMMON DISEASES CAUSED BY WATER POLLUTION

DYSENTERY:

- ✓ Dysentery is a combination of nausea, abdominal cramps coupled with severe diarrhoea.

- ✓ In cases of acute dysentery, one may also experience a high fever and traces of blood in the faecal matter.
- ✓ There are two types of dysentery—Bacillary dysentery, caused by bacteria and Amoebic dysentery caused by amoebae.

ARSENICOSIS:

- ✓ Arsenic is a poisonous substance often released as wastewater by industrial units situated on the banks of rivers.
- ✓ Arsenicosis or Arsenic Poisoning is caused due to chronic exposure to small amounts of arsenic through drinking water.
- ✓ This disease is characterised by painful skin lesions (keratosis), which can progress to cancer.
- ✓ It can also affect your lungs, kidneys, and bladder.

POLIO (INFANTILE PARALYSIS):

- ✓ Poliomyelitis is commonly known as polio.
- ✓ It's an acute viral infection caused by a virus, which passes through water from the faeces of an infected individual.
- ✓ This disease affects the central nervous system.
- ✓ Once an individual contracts this virus, they suffer from fever, headache, and seizures, followed by paralysis.

TRACHOMA (EYE INFECTION):

- ✓ This infection is caused by bacterium Chlamydia Trachomatis that's found in contaminated water.
- ✓ Trachoma results in a coarsening of the inner surface of the eyelids.
- ✓ This leads to pain in the eyes, lesion on the outer surface or cornea, and eventual blindness.
- ✓ Trachoma spreads because of poor sanitation and hygiene conditions.

TYPHOID FEVER:

- ✓ Across the world annually, around 12 million people are affected by Typhoid fever.
- ✓ This infection is caused by Salmonella Typhi bacteria.
- ✓ This disease is contracted by consuming contaminated food or water.
- ✓ The bacteria pass through the intestinal tract and can be identified in stool samples.
- ✓ Its symptoms include nausea, loss of appetite, and headache.

SCHISTOSOMIASIS:

- ✓ This disease is caused by worms that are spread by freshwater snails living in polluted water.
- ✓ It's very common in rural areas where people use local water bodies for bathing and recreational purposes.
- ✓ The worms in the water penetrate into one's skin while in contact with the contaminated water, causing infections in the liver, lungs, intestines, and bladder.

CHOLERA:

- ✓ Cholera is an infection of the small intestine by the bacterium Vibrio Cholerae.
- ✓ This disease can kill within hours if not treated on time.
- ✓ Symptoms of cholera include diarrhoea and vomiting, as well as abdominal cramps and headache.
- ✓ According to the WHO, every year, there are 21,000 to 143,000 deaths worldwide due to this infection.

DIARRHOEA:

- ✓ Diarrhoea is one of the most common diseases caused by water pollution.
- ✓ It is most often caused by water-borne viruses.
- ✓ But bacteria and parasites from water contaminated with faeces are also common causes.
- ✓ It results in passage of loose, watery stools that can cause dehydration and death to young children and infants.

MALARIA:

- ✓ Water pollution has resulted in increased breeding of parasite-carrying mosquitoes.
- ✓ Malaria is a disease caused by parasites, which are spread by female mosquitoes called Anopheles.
- ✓ When mosquitoes bite a person infected with malaria, they can spread the infection to other people.
- ✓ This disease causes high fever, headache, and shivering.
- ✓ In severe cases, it can even lead to complications like severe anaemia, coma, and death.

LEAD POISONING:

- ✓ Lead poisoning is caused due to consumption of water contaminated with lead, often coming from old pipes as well as surface water pollution.

- ✓ This disease is particularly harmful to children and can cause a number of health problems, including organ damage, nervous system disorders, anaemia, high blood pressure, kidney disease and problems with the reproductive system.

PREVENTIVE MEASURES

- ✓ Use Less Plastic. It is very difficult to break down plastic after it is produced.
- ✓ Reuse Items.
- ✓ Recyclable Options.
- ✓ Do Not Dispose of Oils in the Sink.
- ✓ Cleaning Chemicals.
- ✓ Handle Toxic Chemicals Properly.
- ✓ Shop to Stop Water Pollution.
- ✓ Do Not Throw Away Medicines.
- ✓ Avoid Toilets For Throwing Household Items
- ✓ Garbage Disposal
- ✓ Dishwashing or Laundry
- ✓ Limit the Use of Detergents and Bleaches
- ✓ Use Phosphate-Free Detergent
- ✓ Use Environmentally Friendly Detergents
- ✓ Gardening
- ✓ Avoid Pesticides
- ✓ Conserve Soil
- ✓ Do Regular Car Maintenance
- ✓ Oil Spill
- ✓ Cellar Drains or Septic Tanks
- ✓ Just Do Not Litter!
- ✓ Use Water Sparingly
- ✓ Plant Fauna at Lakes or Rivers
- ✓ Clean Up Litter
- ✓ Stop Chemical Pollution
- ✓ Eat Organic Food More
- ✓ Choose Food Wisely

- ✓ Buy Sustainable Meats
- ✓ Best Is Cutting Down on Meat Consumption
- ✓ Stop Immersion of Ashes in the River

AIR POLLUTION

- Air pollution is a mixture of solid particles and gases in the air.
- Car emissions, chemicals from factories, dust, pollen and mold spores may be suspended as particles.
- Ozone, a gas, is a major part of air pollution in cities.
- When ozone forms air pollution, it's also called smog.
- Air pollution is a mix of hazardous substances from both human-made and natural sources.
- Vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production are the primary sources of human-made air pollution.
- Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole.

SOURCES OF AIR POLLUTION

- Mobile sources – such as cars, buses, planes, trucks, and trains.
- Stationary sources – such as power plants, oil refineries, industrial facilities, and factories.
- Area sources – such as agricultural areas, cities, and wood burning fireplaces.
- Fuel combustion from motor vehicles (e.g., cars and heavy-duty vehicles)
- Heat and power generation (e.g., oil and coal power plants and boilers)
- Industrial facilities (e.g., manufacturing factories, mines, and oil refineries)
- The combustion of fossil fuels like coal, petroleum and other factory combustibles is a major cause of air pollution.
- These are generally used in power plants, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices.

CAUSES OF AIR POLLUTION

5 MAJOR CAUSES OF AIR POLLUTION

- ✓ Industry - Industries are a major contributor to air pollution.
- ✓ Vehicle Emissions. Source.
- ✓ Household and Farming Chemicals.

- ✓ Deforestation.
- ✓ Smoking.

INDUSTRY:

- ✓ Industries are a major contributor to air pollution.
- ✓ Industrial processes discharge pollutants such as nitrous oxide and hydrofluorocarbons into the air.
- ✓ Petroleum refineries also liberate lots of hydrocarbons into the air.
- ✓ Agricultural practices like livestock rearing and landfills also add to atmospheric methane concentrations.
- ✓ The overall effect is amplification in the global warming probability**.**

VEHICLE EMISSIONS:

- ✓ Vehicle emissions are another source of fossil fuel emissions which invariably leads to air pollution.
- ✓ Cars, heavy duty trucks, shipping vessels, trains, and airplanes all burn lots of fossil fuels to work.
- ✓ Emissions from automobile engines hold both primary and secondary pollutants.

Figure No.1

- ✓ This is a major cause of pollution and one that is very difficult to deal with as transportation is a major industry in itself.
- ✓ Private transportation accounts for about 10 percent of an individual's carbon footprint, or the amount of carbon dioxide our activities and lifestyle contribute to the atmosphere.

HOUSEHOLD AND FARMING CHEMICALS:

- ✓ Fumigating homes, crop dusting, painting supplies, household cleaning products, over the counter insect/pest killers, fertilizer dust, all of these emit harmful chemicals into the air and lead to pollution.
- ✓ In many cases, when we use these chemicals at offices or homes with no or little ventilation, we may fall sick if we breathe them in for an extended period of time.

DEFORESTATION:

- ✓ Deforestation affects the atmosphere in more than a few ways.
- ✓ When forests are burned and destroyed on purpose and to tremendous extents, this storage area for carbon dioxide is removed, thus increasing the amount of atmospheric carbon dioxide.
- ✓ Wood fires are also another effect of deforestation and can be cause air pollution by discharging particulate matter into the air.
- ✓ These particles can become lodged in the respiratory system, causing irritation to lung tissues.
- ✓ The particles can also worsen existing health conditions such as asthma and other respiratory disorders.

Figure No.2

SMOKING:

- ✓ One can still be at a risk of the dangers of smoking even if they are a nonsmoker.
- ✓ The University of Minnesota estimated that up to 90 percent of the population is habitually exposed to secondhand smoke.
- ✓ Tobacco smoke contains up to 40 carcinogens, making it an especially fatal form of air pollution.
- ✓ If you have smokers in the family air purifiers will ensure that the other members don't suffers from second hand smoke.

Figure No.3

EFFECTS OF AIR POLLUTION

- ➢ Long-term health effects from air pollution include heart disease, lung cancer, and respiratory diseases such as emphysema.
- ➢ Air pollution can also cause long-term damage to people's nerves, brain, kidneys, liver, and other organs.
- ➢ Some scientists suspect air pollutants cause birth defects.
- ➢ Exposure to high levels of air pollution can cause a variety of adverse health outcomes.
- ➢ It increases the risk of respiratory infections, heart disease and lung cancer.
- ➢ Both short and long-term exposure to air pollutants have been associated with health impacts.

- A physical, biological or chemical alteration to the air in the atmosphere can be termed as pollution.
- It occurs when any harmful gases, dust, smoke enters into the atmosphere and makes it difficult for plants, animals, and humans to survive as the air becomes dirty.

SERIOUS EFFECTS OF AIR POLLUTION ON THE ENVIRONMENT:

- ✓ Global Warming.
- ✓ Climate Change.
- ✓ Acid Rain.
- ✓ Smog effect.
- ✓ Deterioration of fields.
- ✓ Extinction of animal species.
- ✓ Respiratory health problems.
- ✓ Deterioration in building materials.

TYPES OF POLLUTANTS:

- Primary air pollutants
- Secondary pollutants
- ✓ Primary air pollutants can be caused by primary sources or secondary sources.
- ✓ The pollutants that are a direct result of the process can be called primary pollutants.
- ✓ A classic example of a primary pollutant would be the sulfur-dioxide emitted from factories.
- ✓ Secondary pollutants are the ones that are caused by the intermingling and reactions of primary pollutants.
- ✓ Smog created by the interactions of several primary pollutants is known as a secondary pollutant.

ENVIRONMENTAL EFFECTS OF AIR POLLUTION

GLOBAL WARMING:

- ✓ Probably global warming is one of the most worrying effects for scientists and environmentalists.
- ✓ Global warming is a direct consequence of the greenhouse effect, which is produced by the high emission of CO_2 and methane into the atmosphere.
- ✓ Most of these emissions are produced by the industry, so this can be remedied by social responsibility and action by companies and factories.

CLIMATE CHANGE:

- ✓ Climate Change is another consequence of global warming.
- ✓ When the temperature of the planet increases, there is a disturbance in the usual climatic cycles, accelerating the changes of these cycles in an evident way.
- ✓ Due to climate change, the mass of the poles is melting, and this is leading to flooding and the rising of sea levels.

ACID RAIN:

- ✓ The gases emitted by industries, power plants, boilers, heating and transport are very toxic.
- ✓ Those gases include sulphur dioxide (SO_2) and nitrogen oxides (NOx) issued into the atmosphere that come from fossil fuels burning.
- ✓ When those substances accumulate in the atmosphere and react with water, they form dilute solutions of nitric and sulphuric acid, and when those concentrations become rain, both the environment and surfaces suffer.

SMOG EFFECT:

- ✓ The smog effect or beret effect happens when there is a kind of dark fog concentrated over the cities and fields.

  That fog is a load of pollutants and can be of 2 types:

- ✓ sulphurous smog and photochemical smog, both dangerous and harmful to health.
- ✓ Both types of smog are a consequence of industrial and urban action.
- ✓ However, sulphurous smog has its origin mainly in the use of coal in many industrial processes.

DETERIORATION OF FIELDS:

- ✓ Acid rain, climate change and smog all damage the Earth surface.
- ✓ Contaminated water and gases seep into the earth, changing the composition of soils.
- ✓ That directly affects agriculture, changing crop cycles and the composition of the food we all eat.

EXTINCTION OF ANIMAL SPECIES:

- ✓ As the ice masses of the poles melt and sea levels rise, many animal species, whose survival depends on oceans and rivers, are threatened.
- ✓ Currents change, ocean temperatures change and migratory cycles change, and many animals are forced to seek food in environments unknown to them.
- ✓ Deforestation and poor soil quality also mean the disappearance of ecosystems and habitats.

- ✓ And definitively, an imbalance in the behavior of many wild species.

RESPIRATORY HEALTH PROBLEMS:

- ✓ It is probably one of the most obvious and worrying effects for human beings.
- ✓ Pollutants can cause respiratory illnesses and allergies ranging from coughs to asthma, cancer or emphysema.
- ✓ Inhalation of toxic agents directly affects the lungs and other organs that make up the respiratory system.
- ✓ Also, poor oxygenation can lead to cardiovascular problems.

DETERIORATION IN BUILDING MATERIALS:

- ✓ Air pollutants also deteriorate and change the constitution of building materials, so many buildings and infrastructure are weakened, eroded or destroyed at an accelerated rate over time.

CHEMICAL SENSITIVITY:

- ✓ People develop intolerances and allergies to many agents present in the atmosphere and to other external agents that can go through due to the holes in the ozone layer.
- ✓ This is because there is a high concentration of chlorofluorocarbons that alter the thickness of the ozone layer.
- ✓ Chlorofluorocarbons (CFCs) are released using aerosols, industrial refrigerants, solvents and other very harmful chemicals.

SKIN DAMAGE:

- ✓ Many of the chemical intolerances directly affect people's skin.
- ✓ However, one of the worst damages is skin cancer.
- ✓ That disease in many cases develops from the direct incidence of ultraviolet light rays on the skin.
- ✓ The ozone layer acts as a filter for those rays.
- ✓ If the ozone layer is thinner, the effectiveness of the filter decreases, letting rays pass, which are very harmful to humans.
- ✓ All those important effects can increase if their causes are not rapidly acted upon.
- ✓ Most of them are the result of very intense, polluting and uncontrolled industrial activity.

DISEASES

- Air pollution is the cause and aggravating factor of many respiratory diseases like chronic obstructive pulmonary disease (COPD) , asthma, and lung cancer.
- The most common diseases caused by air pollution include ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), lung cancer and acute lower respiratory infections in children.
- Short term exposure to air pollution can irritate the eyes, nose and throat and cause upper respiratory infections, headaches, nausea and allergic reactions.
- Long-term exposures can lead to chronic respiratory disease, lung cancer, and heart disease.
- 40% – ischaemic heart disease.
- 40% – stroke.
- 11% – chronic obstructive pulmonary disease.
- 6% - lung cancer.
- 3% – acute lower respiratory infections in children.
- 80%- [(asthma)].

PREVENTIVE MEASURES

- Trees take up carbon dioxide and release oxygen.
- We should use CNG; instead of petrol and diesel in automobiles.
- Avoid unnecessary usage of vehicles.
- Try using public transport more.

USING PUBLIC TRANSPORTS:

- ✓ Using public transport is a sure short way of contributing to less air pollution as it provides with less gas and energy, even carpools contribute to it.
- ✓ In addition to less release of fuels and gas, using a public transport can also help in saving money.

TURN OFF THE LIGHTS WHEN NOT IN USE:

- ✓ The energy that the lights take also contribute to air pollution, thus less consumption of electricity can save energy.
- ✓ Use energy saving fluorescent lights to help the environment.

RECYCLE AND REUSE:

- ✓ The concept of recycle and reuse is not just conserved resources and use them judicially but also is helpful for air pollution as it helps in reducing pollution emissions.
- ✓ The recycled products also take less power to make other products.

NO TO PLASTIC BAGS:

- ✓ The use of plastic products could be very harmful to the environment as they take a very long time to decompose, due to their material made up of oil.
- ✓ The use of paper bags instead is a better alternative as they decompose easily and are recyclable.

REDUCTION OF FOREST FIRES AND SMOKING:

- ✓ The collecting of garbage and getting it on fire in dry seasons or dry leaves catching fires is a huge factor for causing air pollution, moreover smoking also causes air pollution and causes the air quality to worsen along with obviously damaging one's health.

USE OF FANS INSTEAD OF AIR CONDITIONER:

- ✓ The usage of AC's takes a lot of energy and emits a lot of heat which is bad for the environment.
- ✓ AC's also take a lot of power and energy to work as compared to fans.

USE FILTERS FOR CHIMNEYS:

- ✓ The gas that is emitted from fireplaces in homes and factories are extremely dangerous for air pollution and harms the air quality severely.
- ✓ The use of filters should be used at least if the consumption couldn't be lessened, this will help to reduce the effect of harmful gases absorbing in the air.

AVOID USAGE OF CRACKERS:

- ✓ The use of crackers during festivals and weddings is sadly one of the biggest contributors to air pollution, leading to a layer of smog which is extremely harmful for health.
- ✓ So, practice of no crackers should be implemented.

AVOID USING OF PRODUCTS WITH CHEMICALS:

- ✓ Products that use the chemicals in their usage or smell strongly, like paints or perfumes should be used less or outside the house.
- ✓ There can also be an alternative to use products with low chemical content and organic properties.

IMPLEMENT AFFORESTATION:

- ✓ Last but not the least, plant and grow as many trees as possible.
- ✓ The practice of planting trees provides a lot of benefits to the environment and helps with the release of oxygen.

LAND POLLUTION

- ➢ Land pollution refers to the deterioration of the earth's land surfaces, at and below ground level.
- ➢ The cause is the accumulation of solid and liquid waste materials that contaminate groundwater and soil.
- ➢ The higher the permeability of the soil, the more likely that land pollution will occur.
- ➢ Land pollution, the deposition of solid or liquid waste materials on land or underground in a manner that can contaminate the soil and groundwater, threaten public health, and cause unsightly conditions and nuisances.
- ➢ Some common examples include soil erosion or drastically changed climate patterns, particularly where it concerns agriculture.
- ➢ Land pollution can be caused by a few things.
- ➢ The expansion of cities and deforestation, making for less tree over, is a common cause.

TYPES OF SOIL POLLUTANTS:

- ✓ Biological Agents.

Biological agents work inside the soil to introduce manures and digested sludge (coming from the human, bird and animal excreta) into the soil.

- ✓ Agricultural Practices.
- ✓ Radioactive Pollutants.
- ✓ Urban Waste.
- ✓ Industrial Waste.

SOURCES OF LAND POLLUTANTS

- ➢ The source of land pollution comes from the human element such as littering, and waste that is washed ashore from boats, oil rigs, and sewage outlets.
- ➢ Land pollution is a result of dumping garbage, waste, and other toxins making the land contaminated or polluted.

INCREASE IN URBANIZATION:

- ✓ Construction uses up forest land.

- ✓ More constructions mean increase in demand for raw materials like timber.
- ✓ This leads to the exploitation and destruction of forests.

INCREASE IN AGRICULTURAL LAND:

- ✓ As the human population grew there was a greater demand for food.
- ✓ This caused more land allocated to agriculture.
- ✓ Forests were cut down for this purpose.

DOMESTIC WASTE:

- ✓ Every single day, tons and tons of domestic waste is dumped ranging from huge pieces of rubbish such as unused refrigerator to fish bones.
- ✓ If all these wastes are not disposed of properly, the damage they can do to the environment and humankind can be devastating.
- ✓ While waste collected from homes, offices and industries may be recycled or burnt in incinerators, a large amount of rubbish is neither burnt nor recycled but is left in certain areas marked as dumping grounds.
- ✓ We throw away more things today and there is an increase in the quantity of solid waste.
- ✓ This has given rise to problems as new dumping grounds have to be found.

AGRICULTURAL ACTIVITIES:

- ✓ Besides domestic waste, pesticides and herbicides used by farmers to increase crop yields also pollute the land when they are washed into the soil.
- ✓ Pesticides which are persistent in nature are chlorinated hydrocarbon insecticides e.g., DDT, HCH, endrin, lindane, heptachlor, endosulfan etc.
- ✓ Residues of these pesticides in soils have long term effects especially under the temperate conditions.

INDUSTRIAL ACTIVITIES:

- ✓ Industrial activities also are a contributing factor to land pollution.
- ✓ Industrial wastes are the effluents discharged from chemical industries, paper and pulp mills, tanneries, textile mills, steel industries, distilleries, refineries, pesticides and fertilizer industries, pharmaceutical industries, food processing industries, cement industries, thermal and nuclear power plants, mining industries etc.
- ✓ Thermal power plants generate a large quantity of ‘Fly ash’. Huge quantities of these wastes are dumped on land which cause land pollution.
- ✓ Mining also affects ground and surface waters, the aquatic life, vegetation, soils, animals, and the human health. Acid mine drainage can cause damage to streams which in return can kill aquatic life.

CAUSES OF LAND POLLUTION

- Deforestation and Soil Erosion.

Deforestation carried out to create drylands is one of the major concerns.

- Agricultural Activities.
- Mining Activities.
- Overcrowded Landfills.
- Industrialization.
- Urbanization.
- Construction Activities.
- Nuclear Waste.

DEFORESTATION AND SOIL EROSION:

- ✓ Deforestation carried out to create drylands is one of the major concerns.
- ✓ Land conversion, meaning the alteration or modification of the original properties of the land to make it use-worthy for a specific purpose, is another major cause.

AGRICULTURAL ACTIVITIES:

- ✓ With the growing human population, the demand for food has increased considerably.
- ✓ Farmers often use highly toxic fertilizers and pesticides to get rid of insects, fungi and bacteria from their crops.
- ✓ However, with the overuse of these chemicals, they result in contamination and poisoning of soil.

MINING ACTIVITIES:

- ✓ During extraction and mining activities, several land spaces are created beneath the surface.
- ✓ We constantly hear about land caving in, which is nothing but nature's way of filling the spaces left out after mining or extraction activity.

OVERCROWDED LANDFILLS:

- ✓ Each household produces tonnes of garbage each year. Garbage like aluminum, plastic, paper, cloth, wood is collected and sent to the local recycling unit.
- ✓ Items that can not be recycled become a part of the landfills that hamper the beauty of the city and cause land pollution.

INDUSTRIALIZATION:

- ✓ Due to an increase in demand for food, shelter, and house, more goods are produced.

- ✓ This resulted in the creation of more waste that needs to be disposed of.
- ✓ To meet the demand of the growing population, more industries were developed, which led to deforestation.
- ✓ Research and development paved the way for modern fertilizers and chemicals that were highly toxic and led to soil contamination.

URBANIZATION:

- ✓ We humans have been making permanent settlements for at least the past 10,000 years.
- ✓ Most of the cities and towns, and the infrastructure created, will remain with us for thousands of more years into the future.

CONSTRUCTION ACTIVITIES:

- ✓ Due to urbanization, a large number of construction activities are taking place, which has resulted in huge waste articles like wood, metal, bricks, plastic that can be seen by naked eyes outside any building or office which is under construction.

NUCLEAR WASTE:

- ✓ Nuclear plants can produce a huge amount of energy through nuclear fission and fusion.
- ✓ The leftover radioactive material contains harmful and toxic chemicals that can affect human health.
- ✓ They are dumped beneath the earth to avoid any casualty.

SEWAGE TREATMENT:

- ✓ A large amount of solid waste is leftover once the sewage has been treated.
- ✓ The leftover material is then sent to the landfill site, which ends up polluting the environment.

LITTERING:

- ✓ Littering is a common problem, no matter it is a city or a rural region.
- ✓ People just throw their garbage on the ground without caring about the adverse effects on the environment.
- ✓ A common instance is that people just throw their cigarette butt on the ground every time.
- ✓ Since cigarettes contain elements harmful to the environment, it leads to land contamination.

EFFECTS OF LAND POLLUTION

SOIL POLLUTION:

- ✓ Soil pollution is another form of land pollution, where the upper layer of the soil or the topsoil's composition is damaged or becomes altered.
- ✓ This is caused by the overuse of chemical fertilizers, soil erosion triggered by running water and other pest control measures, leading to loss of fertile land for agriculture, forest cover, fodder patches for grazing, etc.

GROUNDWATER POISONING:

- ✓ When harmful substances from industrial processes, chemicals are improperly disposed of on the land or in illegal landfills or storages, the chemicals and other substances could end up in the groundwater system.
- ✓ The process is called leaching.
- ✓ It can happen on farms, industrial sites, and landfills and affect the health of animals, plants and also humans.

DRINKING-WATER PROBLEM:

- ✓ Drinking water is highly affected by land pollution. Nearly 50% of the world's population does not have access to safe drinking water, and each year water-based diseases cause up to 10 million deaths.

CHANGE IN CLIMATE PATTERNS:

- ✓ The effects of land pollution are very hazardous and can lead to the loss of ecosystems.
- ✓ When land is polluted, it directly or indirectly affects the climate patterns.

ENVIRONMENTAL IMPACT:

- ✓ When deforestation is committed, the tree cover is compromised.
- ✓ This leads to a steep imbalance in the rain cycle.
- ✓ A disturbed rain cycle affects a lot of factors.

EFFECT ON HUMAN HEALTH:

- ✓ The land, when contaminated with toxic chemicals and pesticides, lead to potentially fatal problems like skin cancer and the human respiratory ailments in particular.
- ✓ Globally, 9,500 people are diagnosed with skin cancer every day.
- ✓ The toxic chemicals can reach our body through foods and vegetables that we eat as they are grown in polluted soil.
- ✓ Land pollution also caused developmental deficiency in children.

- ✓ Chemicals, such as lead that are commonly found in contaminated soil and water, can impact a child's cognitive development even when the exposure is very low.

CAUSES AIR POLLUTION:

- ✓ Landfills across the city keep on growing due to an increase in waste and are later burned, which leads to air pollution.
- ✓ They become home for rodents, mice, etc., which in turn transmit diseases.

DISTRACTION FOR TOURISTS:

- ✓ The city loses its attraction as a tourist destination as landfills do not look good when you move around the city.
- ✓ It leads to a loss of revenue for the state government.

EFFECT ON WILDLIFE:

- ✓ The animal kingdom has suffered most in the past decades.
- ✓ They face a serious threat with regard to the loss of habitat and natural environment.
- ✓ The constant human activity on land is leaving it polluted, forcing these species to move further away and adapt to new regions or die trying to adjust.
- ✓ Several species are also pushed to the verge of extinction, due to no homeland.

WILDFIRES:

- ✓ When land areas are polluted, they usually become quite dry. The dry conditions created by pollutants in the soil create the perfect environment for wildfires and increases the probability of wildfires dramatically.

HABITAT SHIFTING:

- ✓ When deforestation and soil erosion are in progress, animals are forced to move from their natural habitat to find shelter and food.
- ✓ The change is too traumatic for some animals, and this even leads to loss of life.

OTHER ISSUES:

- ✓ Other issues that we face include increased temperature, unseasonal weather activity, acid rains, etc.
- ✓ The discharge of chemicals on land makes it dangerous for the ecosystem too.
- ✓ These chemicals are consumed by the animals and plants and thereby making their way in the ecosystem.
- ✓ This process is called biomagnification and is a serious threat to the ecology.

ENVIRONMENTAL EFFECTS OF LAND POLLUTION:

- ➢ Effect on Our Environment: Our environment is very badly affected by land pollution.

- Soil erosion and deforestation caused by soil and land pollution lead to landslides and mudslides.
- Toxic waste mixing in the water and land affects flora and fauna very adversely.
- As land pollution and soil erosion progress, animals are forced to shift habitats and adapt to new conditions.
- As a result, some species are at risk of extinction.
- The potential effects of soil contamination on human health include breathing disorders, birth defects, skin diseases, and cancer.

DISEASES:

SHORT TERM DISEASES AND SYMPTOMS:

- ✓ The exposure to environmental pollution caused by soil contaminants may result in an increased risk for developing a series of conditions.
- ✓ One of the most frequently encountered effects of toxic contamination is a series of symptoms that appear immediately after the exposure.
- The most common symptoms that appear after direct exposure to soil contaminants are the following:
- ✓ headache
- ✓ nausea and vomiting
- ✓ chest pain
- ✓ coughing and lung problems
- ✓ fatigue
- ✓ skin rash
- ✓ eye irritations

LONG TERM DISEASES:

- ✓ The inhalation of soil particulate matter and the ingestion of contaminated food can potentially result in serious conditions, of which the most common include:
- ✓ Cancer, including leukemia – caused by the contact with soils contaminated with chemicals (e.g. gasoline, benzene)
- ✓ Nervous system damage – caused especially by the presence of lead (Pb) in soil, and affecting especially children.
- ✓ Neuromuscular blockage and depression of the central nervous system
- ✓ Kidney and liver damage – caused by chemicals such as mercury (Hg)

PREVENTIVE MEASURES:

- Reduce toxic materials.
- Recycle waste materials.
- Buy organics products, especially organic cleaners, pesticides, insecticides and fertilizers.
- Avoid littering.
- Take initiative to inform others about the harmful effects of littering.
- Improve fertility of the land by reforesting.
- Get a better understanding of the soil environment quality baseline.
- Develop necessary legislation on soil pollution control.
- Proper management of agricultural land and the practice of organic farming.
- Proper Solid Waste Treatment.

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – V – GUIDELINES FOR WATER ACT & AIR ACT – SCIA4002

INTRODUCTION

REGULATORY BODY:

- ✓ These are independent governmental bodies established by the government in order to set standards in a specific field of activity, or operations and then to enforce those standards.
- ✓ Regulatory agencies may or may not function outside direct executive supervision.
- ✓ The character and origin of a regulatory agency depend on the nature of its tasks. Generally, such agencies fall into three main categories: independent regulatory commissions; executive agencies; and government corporations.

ROLE OF REGULATORY BODIES:

- ✓ Regulatory bodies, which today comprise national governmental entities, are responsible for formulating and enforcing laws that protect the safety of patients and set basic quality standards for genetic testing.
- ✓ Regulatory authorities will have the overall responsibility to promote, ensure and monitor compliance by approved ethics committees in a country with relevant legislation, regulations and guidelines including guidelines for Good Practice in the Conduct of Clinical Trials in Human Participants in the country.

EXAMPLE OF REGULATORY BODY:

- ✓ These include the Federal Aviation Administration, the Federal Trade Commission, the Securities and Exchange Commission, the Food and Drug Administration, the Occupational Safety and Health Administration, and the Bureau of Alcohol, Tobacco and Firearms.

REGULATORY AGENCIES:

- ✓ Commodity Futures Trading Commission (CFTC)
- ✓ Consumer Product Safety Commission (CPSC)
- ✓ Farm Credit Administration (FCA)
- ✓ Federal Communications Commission (FCC)
- ✓ Federal Deposit Insurance Commission (FDIC)
- ✓ Federal Election Commission (FEC)

- ✓ Federal Energy Regulatory Commission (FERC)
- ✓ Federal Housing Finance Agency (FHFA)

LOCAL BODIES

- ➢ Tamil Nadu is advancing rapidly in industrialization and urbanization 48.45% of the population living in urban areas.
- ➢ Many major policies and schemes are implemented in the state meeting the comprehensive development of the urban areas in capacity building, accessing funds for infrastructure development, providing basic civic services in order to improve the physical quality of life of the people.
- ➢ The urban local bodies strive hard with self-generated revenues and support of Government grants and funds to achieve the above.

ACTS AND RULES:

- ✓ The Chennai Municipal Corporation Act 1919
- ✓ District Municipalities Act 1920
- ✓ Chennai Metropolitan Water Supply and Sewerage Board (Regulations)
- ✓ Chennai Metro Water Act 2018
- ✓ Tamil Nadu Slum Area (Improvements and Clearance) Act 1971
- ✓ Tamil Nadu Housing Board Right to Information Act 2005
- ✓ Tamil Nadu Local Fund Audit Act 2014
- ✓ Tamil Nadu Town and Country Planning Act 1971
- ✓ Manual under Right to information Act 2005 under Housing and Urban Development Department

CENTRAL POLLUTION CONTROL BOARD (CPCB):

- ✓ Principal Functions of the CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution.
- ✓ The Central Pollution Control Board (CPCB) is an autonomous agency.

- ✓ It plays an advisory role to the Government and State Pollution Control Boards (SPCB) in matters relating to the implementation and enforcement of the Air, Water and Environmental Acts.
- ✓ Water (Prevention & Control of Pollution) Act, 1974 is a comprehensive legislation that regulates agencies responsible for checking on water pollution and ambit of pollution control boards both at the centre and states.
- ✓ The Water Act is enacted with the objective of prevention & control of pollution in India.
- ✓ The Act aims at the maintaining or restoring the wholesome nature of water for the establishment of Boards and to vest them with such powers so as to enable them to carry out the purposes of the Act.

SALIENT FEATURES OF THE WATER POLLUTION ACT:

- ✓ Advise the Central Government on any matter concerning the prevention and control of water pollution.
- ✓ Co-ordinate the activities of the State Boards and provide technical assistance and guidance.

TAMIL NADU WATER SUPPLY AND DRAINAGE BOARD (TWAD):

- ✓ Tamil Nadu Water Supply and Drainage Board coordinates with the Government of India's Ministry of Rural Development and Departments of Drinking Water Supply, Ministry of Water Resources, National River Conservation Directorate, Rajiv Gandhi National Drinking Water Mission, Central Ground Water Board, Non-Government Organisations (NGOs), academic institutions, etc., to implement the water supply and sewerage schemes in Tamilnadu.
- ✓ TWAD Board is a public agency formed by the Government of Tamil Nadu, under the Ministry of Local Administration and Water Supply, assigned with the task of implementing all water supply and sewerage schemes to the state of Tamil Nadu (except the Chennai Metropolitan Area).
- ✓ The Tamil Nadu Water Supply and Drainage Board (Twad Board) Is A Statutory Body Corporate Constituted Under Twad Board Act, 1970 On 14.04.1971.
- ✓ Twad Board Is Entrusted with The Development of Water Supply and Sewerage Facilities in The State of Tamil Nadu.

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB)

- ✓ Chennai Metropolitan Water Supply and Sewerage Board, known shortly as CMWSSB, is a statutory board of Government of Tamil Nadu which provides water supply and sewage treatment to the city of Chennai and areas around it.
- ✓ Chennai is one of the metros in India which is dependent mostly on ground water supply.
- ✓ Ground water in Chennai is replenished by rain water and average rainfall in Chennai is 1276 mm.
- ✓ Chennai receives about 985 million liters per day (mld) from various sources against the required amount of 1200 mld and the demand is expected to rise to 2100 mld by 2031.
- ✓ The newly constructed Minjur desalination plant adds another 100 mlds to the city's growing demand.
- ✓ As of 2012, Chennai Metrowater supplies about 830 million litres of water every day to residents and commercial establishments.
- ✓ Chennai has fresh water reservoirs/lakes namely Poondi, Sholavaram, Red Hills, Chembarambakkam and Veeranam cater the daily needs of water for people of Chennai.
- ✓ Chennai receives most of its water from Poondi Lake (3,231 Mcft), Sholavaram Lake (881 Mcft), Red Hills Lake (3,300 Mcft) and Chembarambakkam Lake (3,645 Mcft).
- ✓ The Veeranam Water Supply Project was implemented as an additional source of water to Chennai City.
- ✓ The Project was commissioned in the year 2004 to supply 180 MLD of water to Chennai City by drawing water from Veeranam Lake.
- ✓ This lake receives water from Cauvery River system through Kollidam, Lower Anicut and Vadavar Canal besides rainwater from its own catchment area.

NATIONAL CONCERN FOR ENVIRONMENT:

- ✓ A serious threat to human beings and their environment is the continuous and accelerating overuse and destruction of natural resources.
- ✓ A necessary condition may be an increase in environmental concern and knowledge about the effects and consequences of the ongoing environmental deterioration for future generations.
- ✓ The environmental problems like global warming, acid rain, air pollution, urban sprawl, waste disposal, ozone layer depletion, water pollution, climate change and many more affect every human, animal, and nation on this planet.
- ✓ Major current environmental issues may include climate change, pollution, environmental degradation, and resource depletion.
- ✓ The conservation movement lobbies for protection of endangered species and protection of any ecologically valuable natural areas, genetically modified foods and global warming.
- ✓ The list of issues surrounding our environment go on, but there are three major ones that affect the majority of them overall: global warming and climate change; water pollution and ocean acidification; and loss of biodiversity.

IMPORTANT ENVIRONMENTAL PROTECTION ACTS IN INDIA

Some of the important legislations for environment protection are as follows:

- ✓ The National Green Tribunal Act, 2010.
- ✓ The Air (Prevention and Control of Pollution) Act, 1981.
- ✓ The Water (Prevention and Control of Pollution) Act, 1974.
- ✓ The Environment Protection Act, 1986.
- ✓ The Hazardous Waste Management Regulations, etc.
- ✓ Environment Protection Act, 1986 Act of the Parliament of India.
- ✓ They relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property.

- ✓ The National Environmental Policy Act (NEPA) was passed in 1970 along with the Environmental Quality Improvement Act and the National Environmental Education Act.
- ✓ The main objective of these laws was to protect the environment against public and private harms.

IMPORTANCE OF ENVIRONMENTAL LAW:

- ✓ Environmental law and legislation are central in protecting us humans as well as the different plants and animals in the greater ecosystem that we exist in.
- ✓ Environmental law ensures that individuals, governments and cooperates do not cause harm to the environment or its ecosystems.

CONFERRING POWERS ON THE CENTRAL GOVERNMENT:

- ✓ Take all necessary measures for protecting quality of environment
- ✓ Co-ordinate actions of States, officers and other authorities under this Act.
- ✓ Plan and execute a nationwide programme for prevention, control and abatement of environmental pollution.

OBJECTIVES OF THIS ENVIRONMENT PROTECTION ACT:

- ✓ To implement the decisions made at the UN Conference on Human Environment that was held in Stockholm in the year 1972.
- ✓ To take strict actions against all those who harm the environment.
- ✓ To protect and improve the environment and environmental conditions.

IMPORTANT ENVIRONMENTAL ACTS IN INDIA:

- ✓ Air (Prevention and Control of Pollution) Act, 1981.
- ✓ Biological Diversity Act, 2002.
- ✓ Environment (Protection) Act, 1986.
- ✓ Forest Conservation Act, 1980.
- ✓ Indian Forest Act, 1927.
- ✓ National Green Tribunal Act, 2010.
- ✓ Protection of Plant Varieties and Farmers' Rights Act of 2001.
- ✓ Public Liability Insurance Act, 1991.

- ✓ The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.
- ✓ Water (Prevention and Control of Pollution), 1974.
- ✓ Wild Life (Protection) Amendment Act, 2002.
- ✓ Wildlife Protection Act of 1972.
- ✓ Noise Pollution Act.
- ✓ Hazardous waste Handling and management act, 1989.

WATER PREVENTION AND CONTROL OF POLLUTION ACT:

- ✓ An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers.
- ✓ Water (Prevention & Control of Pollution) Act, 1974 is a comprehensive legislation that regulates agencies responsible for checking on water pollution and ambit of pollution control boards both at the centre and states.

OBJECTIVES OF THE WATER ACT:

- ✓ The main objectives of the Water Act are to provide for prevention, control and abatement of water pollution and the maintenance or restoration of the wholesomeness of water.
- ✓ It is designed to assess pollution levels and punish polluters.

GOALS OF CLEAN WATER ACT:

- ✓ The CWA aims to prevent, reduce, and eliminate pollution in the nation's water in order to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters “.
- ✓ The Clean Water Act is a U.S. federal law that regulates the discharge of pollutants into the nation's surface waters, including lakes, rivers, streams, wetlands, and coastal areas.
- ✓ Passed in 1972 and amended in 1977 and 1987, the Clean Water Act was originally known as the Federal Water Pollution Control Act

- ✓ The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.
- ✓ Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry.

AIR PREVENTION AND CONTROL OF POLLUTION ACT:

- ✓ An Act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.
- ✓ Air pollutant" means any solid, liquid or gaseous substance 2[(including noise)] present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment; "Air pollution," means the presence in the atmosphere of any air.
- ✓ According to the World Health Organization, the capital city of New Delhi is one of the top ten most polluted cities in the world.
- ✓ Surveys indicate that in New Delhi the incidence of respiratory diseases due to air pollution is about 12 times the national average.

CLEAN AIR ACT:

Four major regulatory programs affecting stationary sources were initiated:

- ✓ National Ambient Air Quality Standards (NAAQS, pronounced "knacks")
- ✓ State Implementation Plans (SIPs)
- ✓ New Source Performance Standards (NSPS)
- ✓ National Emission Standards for Hazardous Air Pollutants (NESHAPs).