The background of the slide is a photograph of a heavily polluted body of water. The water is a murky, brownish-grey color, and the surface is covered with a dense layer of floating debris. This includes numerous pieces of plastic waste, such as white and clear plastic bottles, some of which are partially submerged. There are also pieces of brown cardboard, crumpled paper, and other unidentifiable pieces of trash. The overall scene depicts a significant environmental problem, likely related to water pollution and waste management.

MODULE 3

ENVIRONMENTAL POLLUTION

WATER POLLUTION

- Prof. Rohan Dasgupta

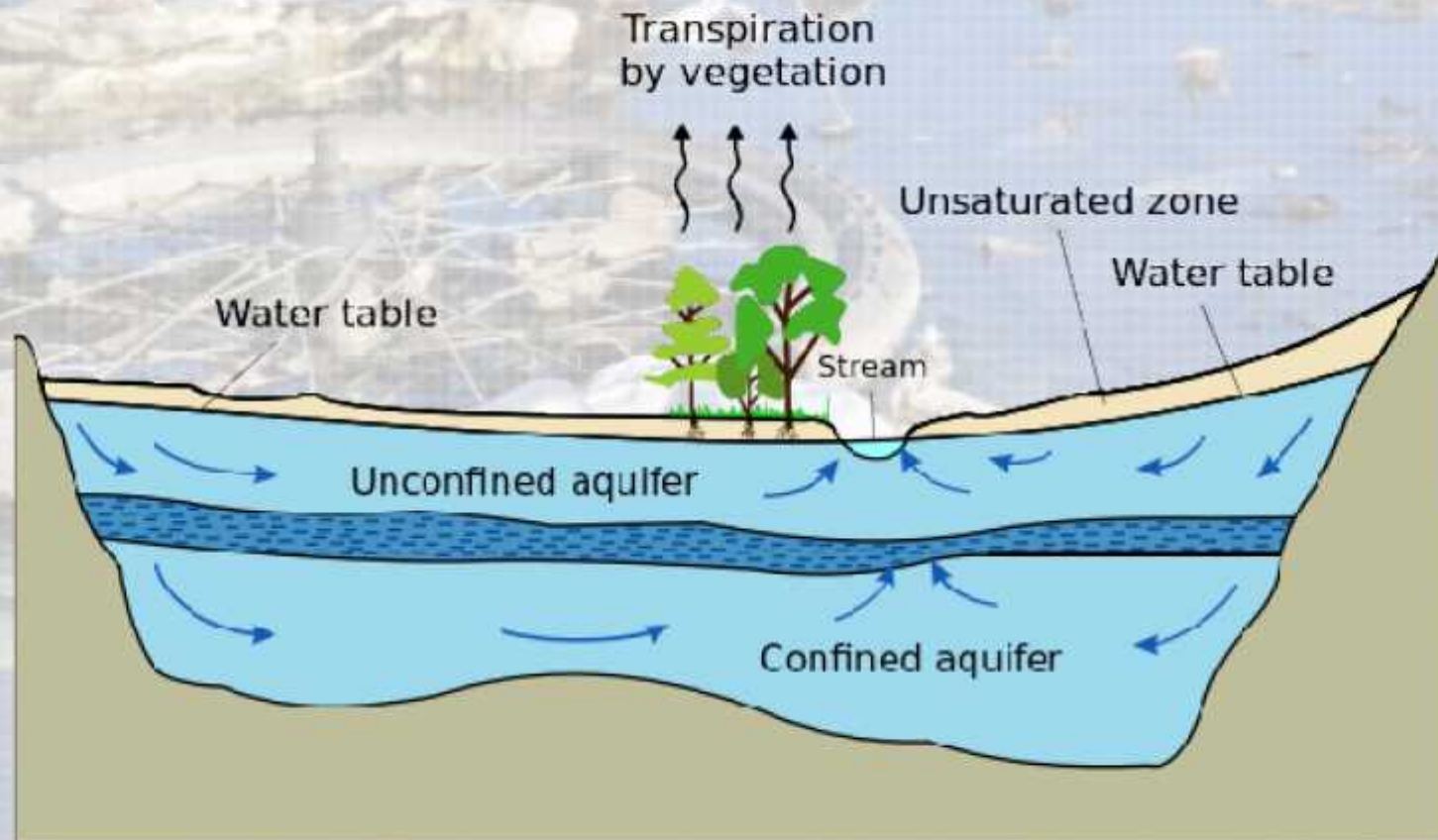
- **Water pollution** is the contamination of water bodies (e.g. lakes, rivers, oceans, *aquifers* and *groundwater*).
- Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water, or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish.



- This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.

Groundwater is the water present beneath Earth's surface in soil pore spaces and in the fractures of rock formations.

Aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well.



FACTS ABOUT WATER POLLUTION

- Water pollution accounts for the deaths of more than 14,000 people daily.
- An estimated 580 people in India die of water pollution related illness every day.
- Around 90% of the water in the cities of China is polluted, and as of 2007, half a billion Chinese had no access to safe drinking water.
- One quarter the length of China's 7 main rivers were so poisoned the water harmed the skin.
- In the U.S. 45% of assessed stream miles, 47% of assessed lake acres and 32% of assessed bays and estuarine square miles are classified as polluted.

SOURCES OF WATER POLLUTION

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- **Point Sources:**

Point source water pollution refers to contaminants that enter a waterway from a single, identifiable source.



Examples: pipes, ditches, discharges from a sewage treatment plant, a factory, city storm drain, municipal storm sewer systems, industrial waste water such as from construction sites

SOURCES OF WATER POLLUTION

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- **Non-Point Sources (NPS):**

Nonpoint source pollution refers to diffuse contamination that does not originate from a single discrete source.

NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area.

A common example is the leaching out of nitrogen compounds from fertilized agricultural lands.

Nutrient runoff in storm water from "sheet flow" over an agricultural field or a forest are also cited as examples of NPS pollution.

Contaminated storm water washed off of parking lots, roads and highways, called *urban runoff*, is sometimes included under the category of NPS pollution. *However, because this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters, it becomes a point source.*

INDICATORS OF **W**ATER **P**OLLUTION

- **Bad taste**
- **Offensive odour**
- **Visible turbidity**
- **Reduction in the number of aquatic lives**
- **Oil or grease floating on the surface of water**
- **Unrestricted growth of aquatic weeds in water bodies**
- **Outbreak of an epidemic**



CAUSES OF **W**ATER **P**OLLUTION / **P**OLLUTANTS

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1. **Industrial Waste**
2. **Natural Sources**
3. **Agricultural Chemicals**
4. **Domestic Sewage**
5. **Thermal and Radioactive Waste**
6. **Biodegradable and Non-Biodegradable Waste**

CAUSES OF WATER POLLUTION / POLLUTANTS

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1. Industrial Waste:

- All the industries discharge the waste by-products from the manufacturing processes into rivers or other water bodies.
- Most of the rivers and fresh water streams are badly polluted with industrial effluents from industries such as paper and pulp, refineries, textiles, distilleries and steel industries.



CAUSES OF WATER POLLUTION / POLLUTANTS

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1. Industrial Waste:

- Industrial waste can be categorized as:
 - i) Organic substances such as phenol and alcohol that increase the BOD by decreasing the oxygen content.
 - ii) Inorganic substances such as chlorides, nitrogen and carbonates that encourage the growth of micro-organisms and make unfit for use.
 - iii) Acids and alkalis which change the pH of water thereby posing a threat to aquatic life.
 - iv) Toxic substances such as cyanide, acetylene and heavy metals like mercury, lead and arsenic that cause extensive, irreversible damage to plant and animal life.
 - v) Oil and other floating impurities that interfere with self-purification of water bodies.
 - vi) Colour producing dyes that change the colour of the water with depleting oxygen content thereby affecting aquatic life.

CAUSES OF WATER POLLUTION / POLLUTANTS

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2. Natural Sources:

- Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes cause major changes in water quality and the ecological status of water.
- While many of the chemicals and substances that cause water pollution may be naturally occurring (calcium, sodium, iron, manganese etc.), the concentration is often the key in determining what is a natural component of water and what is a contaminant.
- High concentrations of naturally occurring substances can have negative impacts on aquatic flora and fauna.



CAUSES OF WATER POLLUTION / POLLUTANTS

Jun '13

2. Natural Sources:



- Oxygen-depleting substances may be natural materials such as plant matter (e.g. leaves and grass).
- Other natural and anthropogenic substances may cause turbidity (cloudiness) which blocks light and disrupts plant growth, and clogs the gills of some fish species.
- Rain water contains varying amount of pollutants like ammonia, nitrogen, phosphorous, lead, dust, etc. depending on the atmospheric pollution of that place.

CAUSES OF WATER POLLUTION / POLLUTANTS

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3. Agricultural Chemicals:



- ✓ **Fertilizers:** Excessive use of chemical fertilizers results in accumulation of nitrogen, phosphorous and water on land. These are washed off the land with water through rainfall and irrigation into water bodies thereby polluting the water.
- ✓ **Pesticides:** They not only kill targeted pests but also affect the untargeted helpful organisms. Their effects are long lasting.

CAUSES OF WATER POLLUTION / POLLUTANTS

Jun '13

4. Domestic sewage:

- It consists of water borne wastes of the human community.
- It contains 99% water and 1% solid. Out of which 70% are organic (proteins, carbohydrates, fats) and 30% are inorganic (salt, minerals).
- Mostly it is disposed off as such in treated, partly or untreated form in nearby lakes, rivers or sea, where it causes pollution.



CAUSES OF WATER POLLUTION / POLLUTANTS

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5. Thermal and Radioactive Waste:

- Different industries and nuclear power plants use water and discharge the heated water into nearby water bodies.
- Nuclear reactors, nuclear explosions, nuclear war, medicinal use and research laboratories are the main sources of radioactive waste.
- These are most toxic as their effect persists for a number of generations..



CAUSES OF WATER POLLUTION / POLLUTANTS

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6. Biodegradable and Non-Biodegradable Waste:

- *Biodegradable pollutants* consist mainly of organic matter from domestic sewage. They are decomposed by microorganisms naturally or can be artificially decomposed in chemical treatment plants. Excessive biodegradable waste in the environment leads to problem in dispersal or recycling posing a threat to the environment.
- *Non-biodegradable wastes* includes plastic bags, long chain detergents, aluminium cans, glass and phenolic chemicals which can neither be decomposed nor recycled. These are used only for filling lands.



MEASUREMENT OF WATER POLLUTION

Sample collection + Testing

➤ Sample Collection:

i) Manual collection

ii) Auto-sample collection



MEASUREMENT OF WATER POLLUTION

➤ Testing:

- i) Physical Testing [temperature, total suspended solid (TSS), turbidity etc.]
- ii) Chemical Testing [pH level, biochemical oxygen demand (BOD), chemical oxygen demand (COD), nutrients (nitrate and phosphate compounds), metals (copper, zinc, cadmium, lead and mercury), oil and grease , total petroleum hydrocarbons (TPH) and pesticides]
- iii) Biological Testing [use of plant, animal, and/or microbial indicators to monitor the health of an aquatic ecosystem]



Turbidity Test Apparatus



BOD Incubator



COD Incubator



pH Meter

CONCEPT OF WASTEWATER

- **Wastewater**, also written as **waste water**, is any water that has been adversely affected in quality by anthropogenic influence.
- Wastewater can originate from a combination of domestic, industrial, commercial or agricultural activities, surface runoff or stormwater, and from sewer inflow or infiltration.



CONCEPT OF WASTEWATER

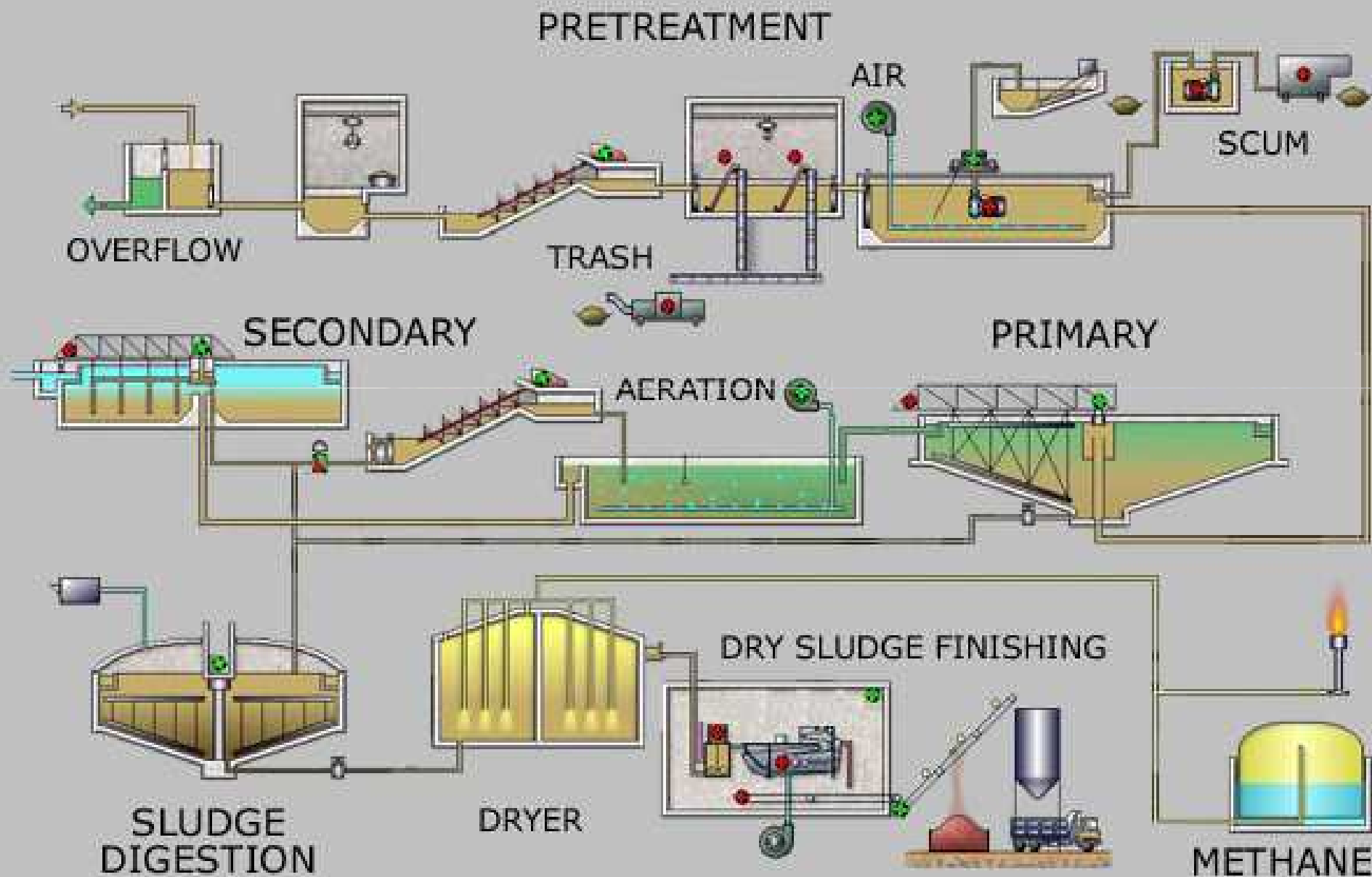
- **Domestic Wastewater –**
 - ✓ Human waste (feces, used toilet paper or wipes, urine, or other bodily fluids), also known as blackwater, usually from lavatories;
 - ✓ Cesspit leakage;
 - ✓ Septic tank discharge;
 - ✓ Sewage treatment plant discharge;
 - ✓ Washing water (personal, clothes, floors, dishes, etc.), also known as greywater or sullage

CONCEPT OF WASTEWATER

- **Industrial Wastewater –**

- ✓ Industrial cooling waters (biocides, heat, slimes, silt);
- ✓ Industrial process waters;
- ✓ Organic or biodegradable waste, including waste from abattoirs, creameries, and ice cream manufacture;
- ✓ Organic or non bio-degradable/difficult-to-treat waste (pharmaceutical or pesticide manufacturing);
- ✓ Extreme pH waste (from acid/alkali manufacturing, metal plating);
- ✓ Toxic waste (metal plating, cyanide production, pesticide manufacturing, etc.);
- ✓ Solids and emulsions (paper manufacturing, foodstuffs, lubricating and hydraulic oil manufacturing, etc.);
- ✓ Hydraulic fracturing
- ✓ Produced water from oil & natural gas production

SEWAGE TREATMENT



SEWAGE TREATMENT

➤ Pretreatment:

Pretreatment removes all materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers. Objects commonly removed during pretreatment include trash, tree limbs, leaves, branches, and other large objects.

• **Bar Screen –**

The influent in sewage water passes through a bar screen to remove all large objects like cans, rags, sticks, plastic packets etc. carried in the sewage stream. This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations. The solids are collected and later disposed in a landfill, or incinerated.

SEWAGE TREATMENT

➤ Pretreatment:

- **Grit Removal** - Pretreatment may include a sand or grit channel or chamber, where the velocity of the incoming sewage is adjusted to allow the settlement of sand, grit, stones, and broken glass. These particles are removed because they may damage pumps and other equipment. For small sanitary sewer systems, the grit chambers may not be necessary, but grit removal is desirable at larger plants. Grit chambers come in 3 types: horizontal grit chambers, aerated grit chambers and vortex grit chambers.

- **Fat and Grease Removal** - Fat and grease are removed by passing the sewage through a small tank where skimmers collect the fat floating on the surface. Air blowers in the base of the tank may also be used to help recover the fat as a froth.

SEWAGE TREATMENT

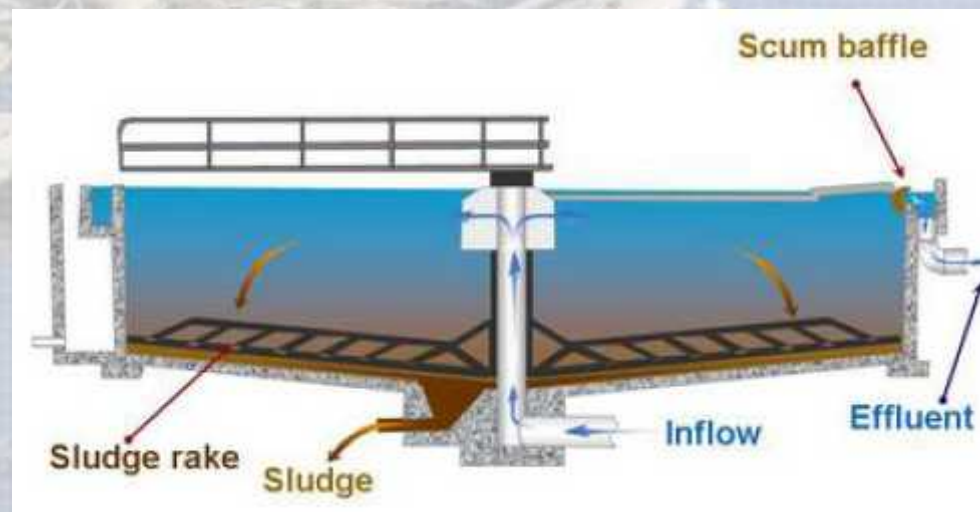
➤ Pretreatment:

- **Flow Equalization** - Clarifiers and mechanized secondary treatment are more efficient under uniform flow conditions. Equalization basins may be used for temporary storage of diurnal or wet-weather flow peaks. Basins provide a place to temporarily hold incoming sewage during plant maintenance and a means of diluting and distributing batch discharges of toxic or high-strength waste which might otherwise inhibit biological secondary treatment (including portable toilet waste, vehicle holding tanks, and septic tank pumpers). Flow equalization basins require variable discharge control, typically include provisions for bypass and cleaning, and may also include aerators. Cleaning may be easier if the basin is downstream of screening and grit removal.

SEWAGE TREATMENT

➤ Primary Treatment:

In the primary sedimentation stage, sewage flows through large tanks, commonly called "pre-settling basins", "primary sedimentation tanks" or "primary clarifiers". The tanks are used to settle sludge while grease and oils rise to the surface and are skimmed off. Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank where it is pumped to sludge treatment facilities. Grease and oil from the floating material can sometimes be recovered for saponification.



SEWAGE TREATMENT

➤ Secondary Treatment:

Secondary treatment is designed to substantially degrade the biological content of the sewage which are derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. To be effective, the biota require both oxygen and food to live. The bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc.

List of process types: Activated sludge, Aerated lagoon, Aerobic granulation, Constructed wetland, Membrane bioreactor, Rotating biological contactor, Sequencing batch reactor and Trickling filter

SEWAGE TREATMENT

➤ Tertiary Treatment:

The purpose of tertiary treatment is to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (sea, river, lake, wet lands, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practised, it is always the final process. It is also called "effluent polishing."

- Biological Nutrient Removal
- Nitrogen Removal
- Phosphorus Removal
- Disinfection
- Environmental Persistent Permanent Pollutant (EPPP) Removal
- Odour Control

CONTROL MEASURES FOR WATER POLLUTION

- ✓ The most effective method to control water pollution is to prevent or minimize the mixing of pollutants into water bodies.
- ✓ Water Prevention and Control of Pollution Act, 1972, was enacted by government of India to control all types of water pollution.
It cares for maintenance and restoration of water of all types, such as surface water and ground water.
- ✓ Apart from legislation, each individual should take care of water quality and refrain from polluting water.
- ✓ Industries should treat their effluents before they dispose it into water bodies.

CASE STUDY: MINAMATA DISEASE

Jun '13

Minamata disease: sometimes referred to as Chisso-Minamata disease is a neurological syndrome caused by severe mercury poisoning.

Symptoms include:

- ataxia,
- numbness in the hands and feet,
- general muscle weakness,
- narrowing of the field of vision and
- damage to hearing and speech.

In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect fetuses in the womb.



CASE STUDY: MINAMATA DISEASE

Jun '13

- Minamata disease was first discovered in Minamata city in Japan in 1956.
- It was caused by the release of methyl mercury in the industrial wastewater from the Chisso Corporation's chemical factory, which continued from 1932 to 1968.
- This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which, when eaten by the local population, resulted in mercury poisoning.
- While cat, dog, pig and human deaths continued for 36 years, the government and company did little to prevent the pollution. The animal effects were severe enough in cats that they came to be named as having "dancing cat fever".

A photograph of a polluted body of water, likely a river or stream. The water is dark blue and filled with various pieces of trash, including plastic bottles, cups, and other debris. The background shows a rocky shoreline with more trash scattered around. The text "Thank you!" is overlaid in a large, black, cursive font in the center of the image.

Thank you!