GE 2211 Environmental Science and Engineering

Unit – III

www.msubbu.in

Water Pollution

M. Subramanian

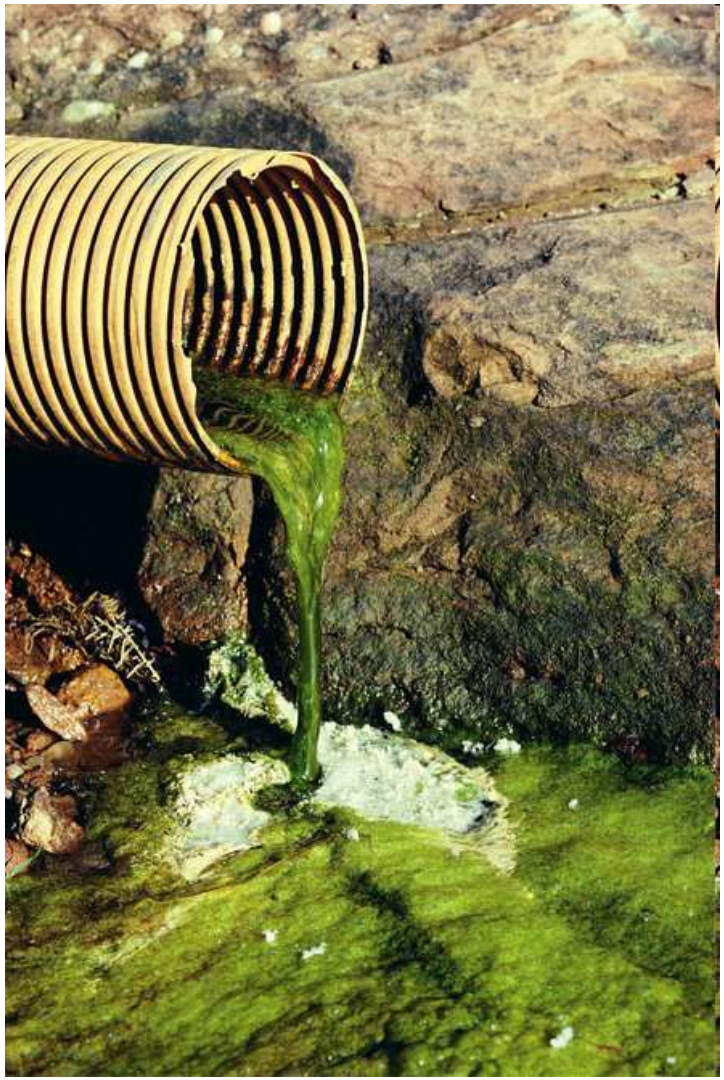
Assistant Professor
Department of Chemical Engineering
Sri Sivasubramaniya Nadar College of Engineering
Kalavakkam – 603 110, Kanchipuram (Dist)
Tamil Nadu, India
msubbu.in[AT]gmail.com

Contents

- Definition – causes, effects and control measures of water pollution

Un-polluted water – used as drinking water source in villages

Polluted water bodies



Introduction

- **Water pollution** is the contamination of water bodies such as lakes, rivers, oceans, and groundwater.
- All water pollution affects organisms and plants that live in these water bodies and in almost all cases the effect is damaging either to individual species and populations but also to the natural biological communities.
- It occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful constituents.
- Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, like serving as drinking water, and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish

Effects of Water Pollution

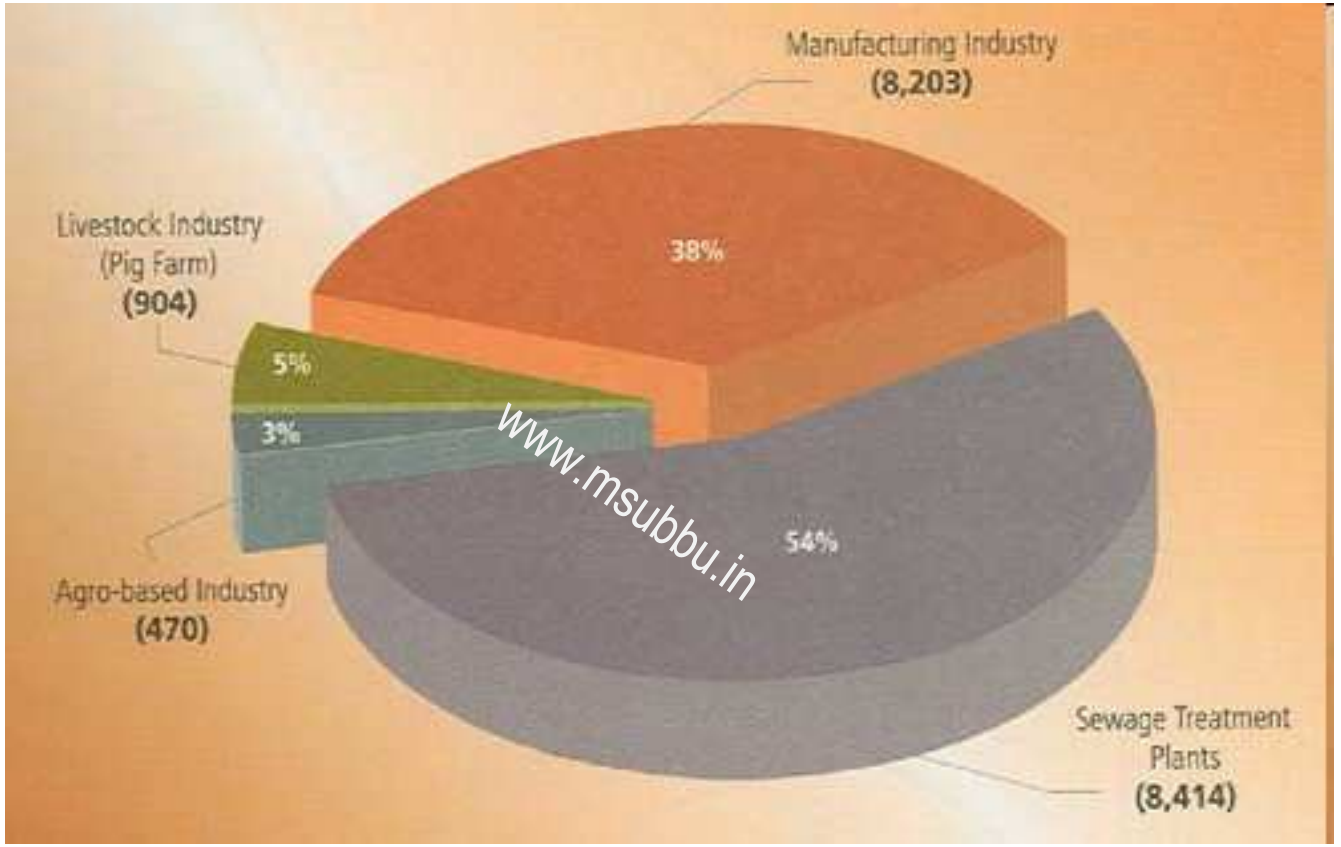
- Fertilizer, animal manure, and waste-treatment plant effluent all contain nutrients that stimulate excessive plant and algal growth in freshwater bodies. When the plants die and decompose, dissolved oxygen is depleted, causing die-offs of fish and other species living in the water.

- Persistent organochlorine insecticides, such as DDT, deposited in lake sediments can bioaccumulate, harming the fish and birds that eat them.

- Human and animal fecal waste contain disease-carrying organisms such as the bacterium *Escherichia coli (E. coli)* and pathogens that causes cholera, typhoid, etc

Minamata disease

- It is a neurological syndrome caused by severe mercury poisoning
- Minamata disease was first discovered in Minamata city in Kumamoto prefecture, 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 populace resulted in mercury poisoning.



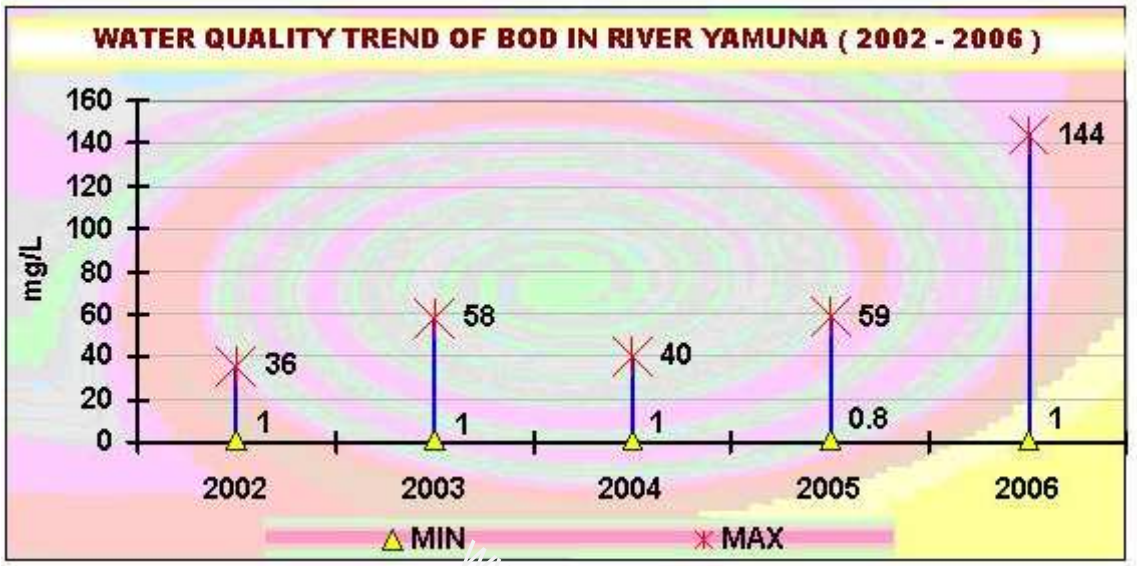
Composition of Water Pollution Sources by Sector, 2004 (Malaysia)

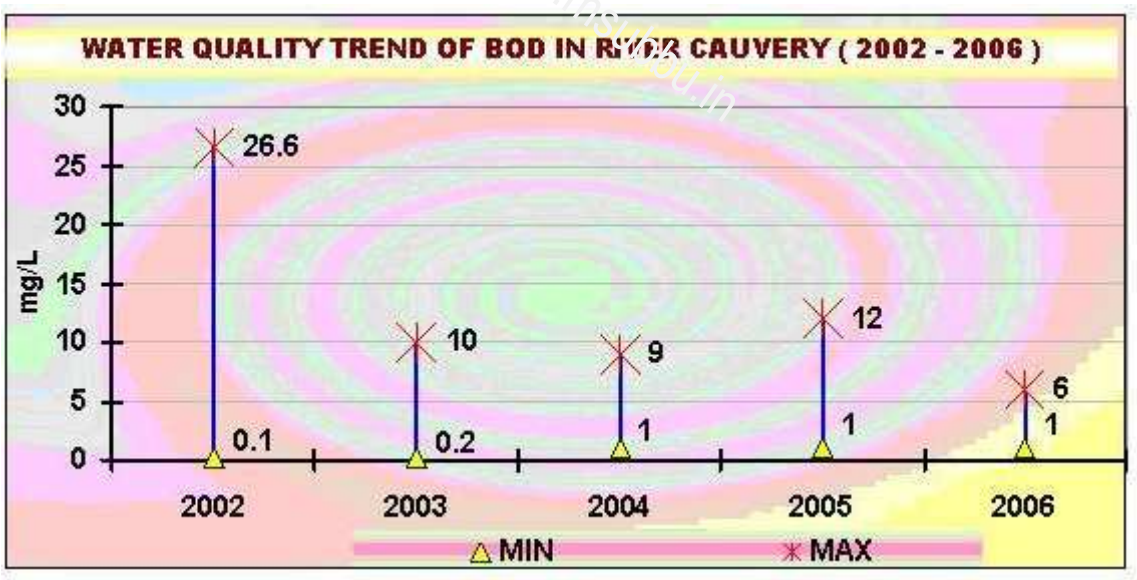
Water Quality Parameters

- **Chemical assessment**
  - Conductivity (also see salinity)
  - Dissolved Oxygen (DO)
  - nitrate-N
  - orthophosphates
  - Chemical oxygen demand (COD)
  - Biochemical oxygen demand (BOD)
  - Pesticides
- **Physical assessment**
  - pH
  - Temperature
  - Total suspended solids (TSS)
  - Turbidity
- **Biological assessment**
  - Pathogens

Water Quality Criteria (CPCB, India)

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	• Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH betwwn 6.0 to 8.5 • Electrical Conductivity at 25°C micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2mg/l
	Below-E	**Not Meeting A, B, C, D & E Criteria**





Source: CPCB, India

Water Pollutants

- **Microbiological**
  - Disease-causing (pathogenic) microorganisms, like bacteria, viruses and protozoa can cause swimmers to get sick. Fish and shellfish can become contaminated and people who eat them can become ill. Some serious diseases like polio and cholera are waterborne.

- **Chemical**
  - A whole variety of chemicals from industry, such as metals and solvents, and even chemicals which are formed from the breakdown of natural wastes (ammonia, for instance) are poisonous to fish and other aquatic life.
  - Pesticides used in agriculture and around the home - insecticides for controlling insects and herbicides for controlling weeds - are another type of toxic chemical. Some of these can accumulate in fish and shellfish and poison people, animals, and birds that eat them.

Water Pollutants (contd.)

- **Oxygen-depleting Substances**
  - Many wastes are *biodegradable*, that is, they can be broken down and used as food by microorganisms like bacteria.
  - We tend to think of biodegradable wastes as being preferable to non-biodegradable ones, because they will be broken down and not remain in the environment for very long times. Too much biodegradable material, though, can cause the serious problem of *oxygen depletion* in receiving waters.
  - *Aerobic* microorganisms those which use dissolved oxygen convert the nitrogen, sulfur, and carbon compounds that are present in the wastewater into odorless and relatively harmless *oxygenated* forms like nitrates, sulfates and carbonates, But these *anaerobic* microorganisms produce toxic and smelly ammonia, amines, and sulfides, and flammable methane (swamp

BOD

- Biological Oxygen Demand (BOD): BOD is defined as the amount of oxygen needed by aerobic decomposers to breakdown the organic materials in a given volume of water at a certain temperature over a specified time period.

- BOD is caused by organic water pollutants that are oxidized by naturally-occurring micro-organisms. This 'biological oxygen demand' removes dissolved oxygen from the water and can seriously damage some fish species which have adapted to the previous dissolved oxygen level.

- The most common measure for BOD is the amount of oxygen used by micro-organisms to oxidize the organic waste in a standard sample of pollutant during a five-day period (5-day BOD)

Typical BOD values

- Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L. Moderately polluted rivers may have a BOD value in the range of 2 to 8 mg/L.

- Municipal sewage that is efficiently treated by a three-stage process would have a value of about 20 mg/L or less.

- Untreated sewage varies, but averages around 600 mg/L in Europe and as low as 200 mg/L in the U.S., or where there is severe groundwater or surface water infiltration. (The generally lower values in the U.S. derive from the much greater water use per capita than in other parts of the world.)

COD

- Chemical Oxidation Demand
- COD is the amount of oxygen required for the chemical oxidation of organic matter with the help of strong chemical oxidants.
- COD is higher than BOD

Water Pollutants (contd.)

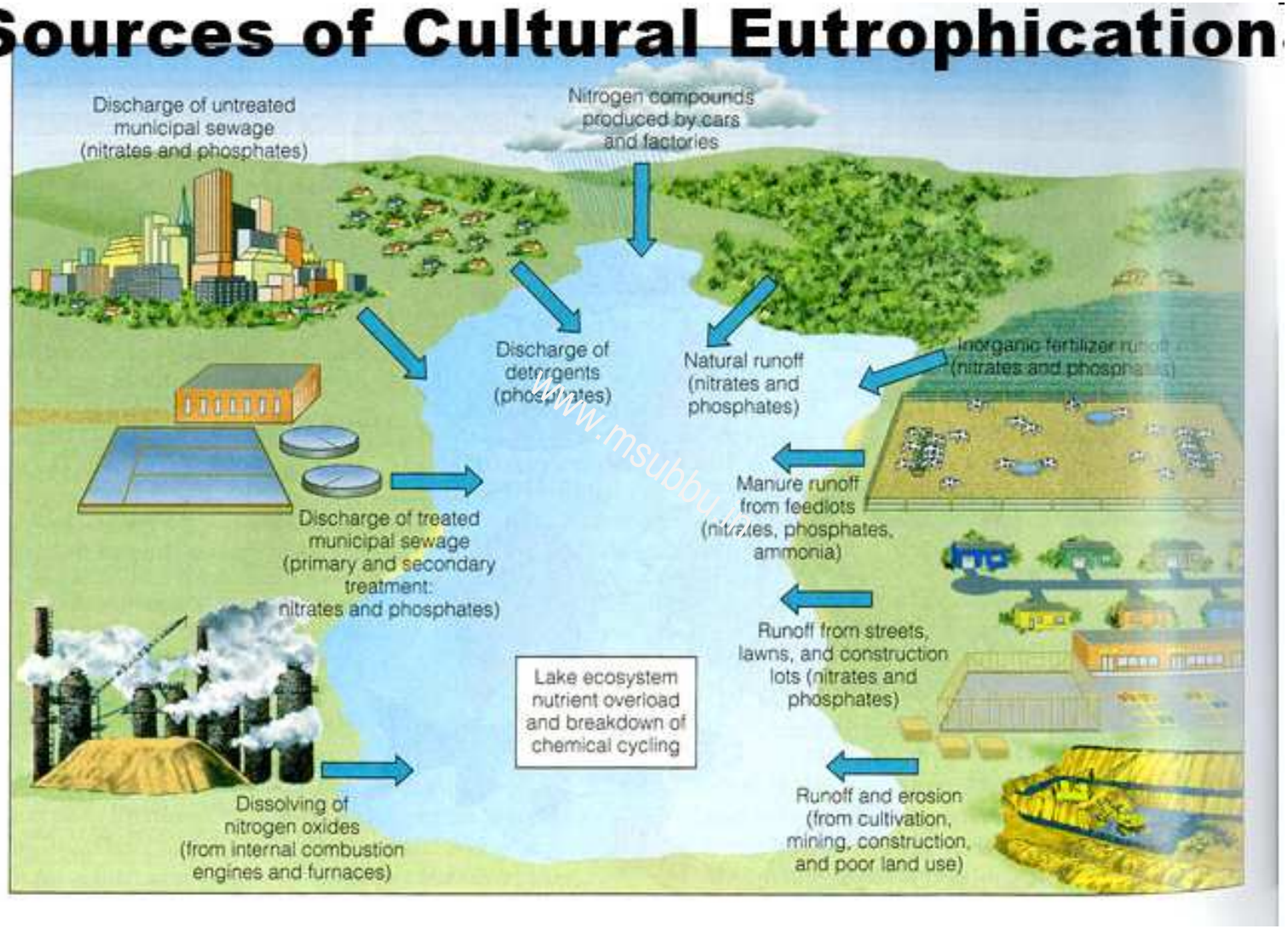
- **Nutrients**
  - The elements phosphorus and nitrogen are necessary for plant growth, and are plentiful in untreated wastewater.
  - Added to lakes and streams, they cause nuisance growth of aquatic weeds, as well as "blooms" of algae, which are microscopic plants. This can cause several problems. Weeds can make a lake unsuitable for swimming and boating. Algae and weeds die and become biodegradable material, which can cause the problems
  - If the water is used as a drinking water source, algae can clog filters and impart unpleasant tastes and odors to the finished water.

Eutrophication

- **Eutrophication** is an increase in the concentration of chemical nutrients in an ecosystem to an extent that increases in the primary productivity of the ecosystem.
- Depending on the degree of eutrophication, subsequent negative environmental effects such as anoxia and severe reductions in water quality, fish, and other animal populations may occur
- When unusually large concentrations of nutrients are present in water bodies, there is an excess of growth of algae known as algal bloom.
- This produces an unsightly green slime layer over the surface of water body. This slime layer reduces the penetration of light and restricts atmospheric reoxygenation of the water.
- The dense algal growth eventually dies and the subsequent biodegradation produces oxygen deficit which can result in foul smelling anaerobic conditions.
- The anaerobic conditions created by rotting algae can present health hazard to aquatic systems.
- Thus with large inputs of nutrients from human sources, the bacterial decomposition cannot keep pace with the productivity and sedimentation is accelerated, whereby eutrophication only is favoured

Eutrophication of Ranchi pond

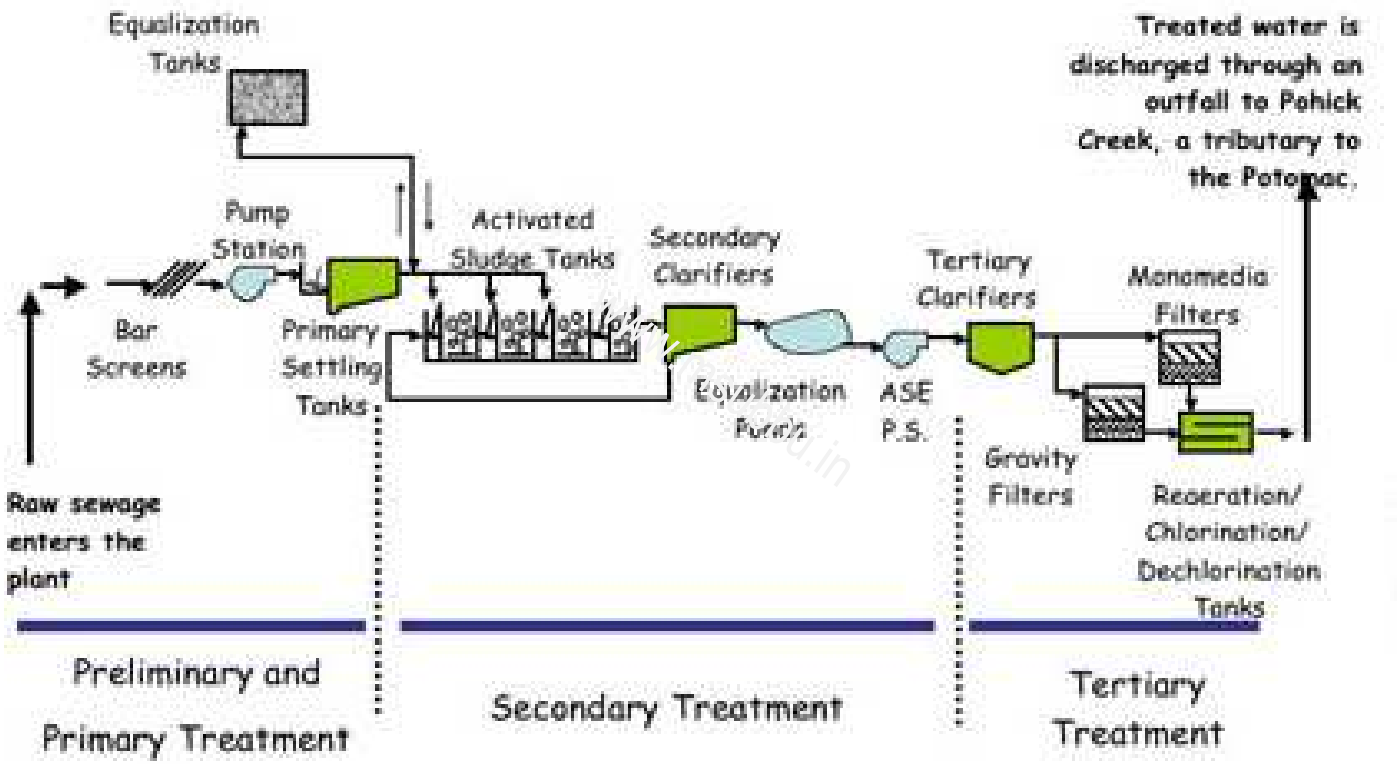
Sources of Cultural Eutrophication

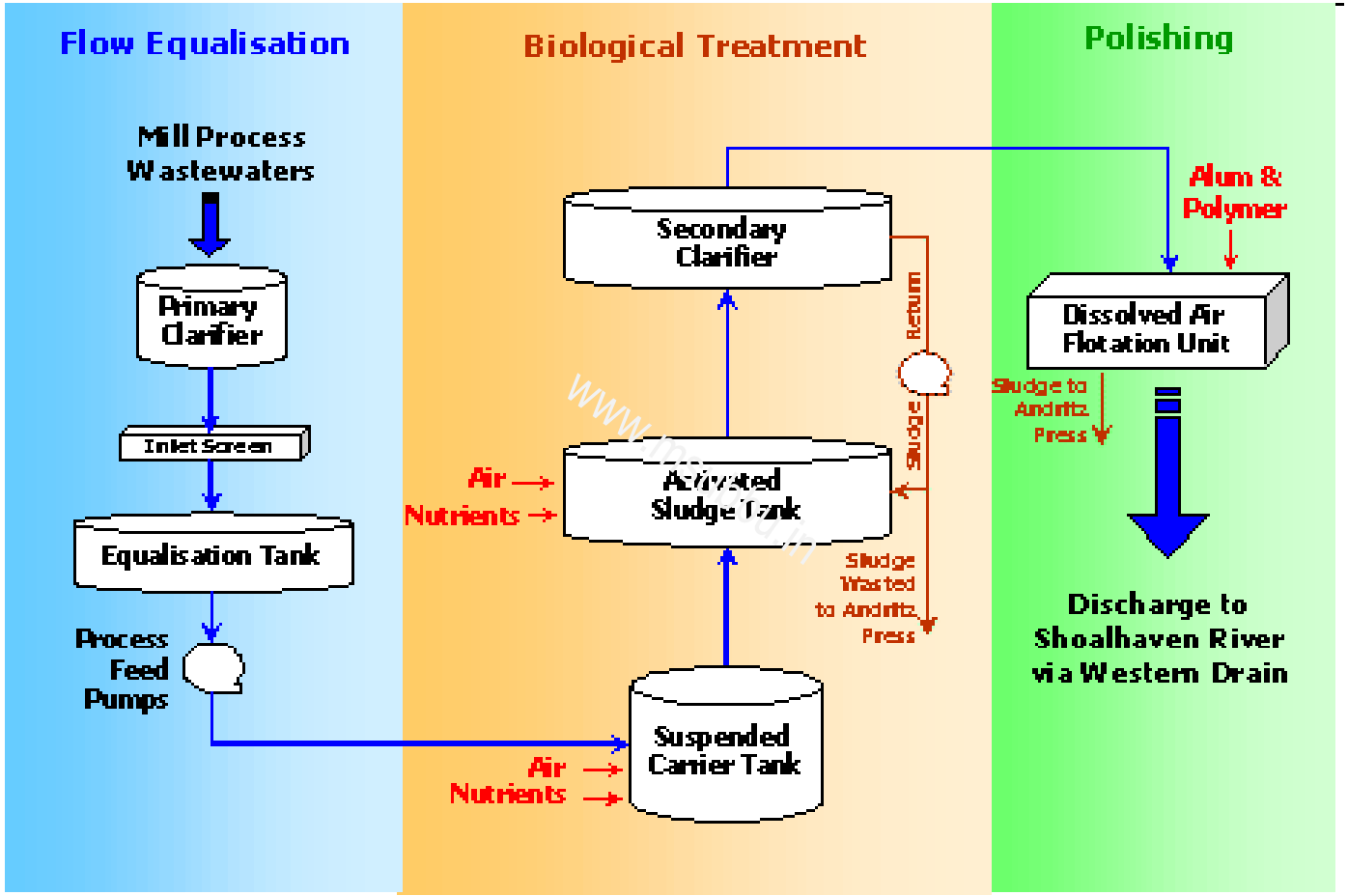


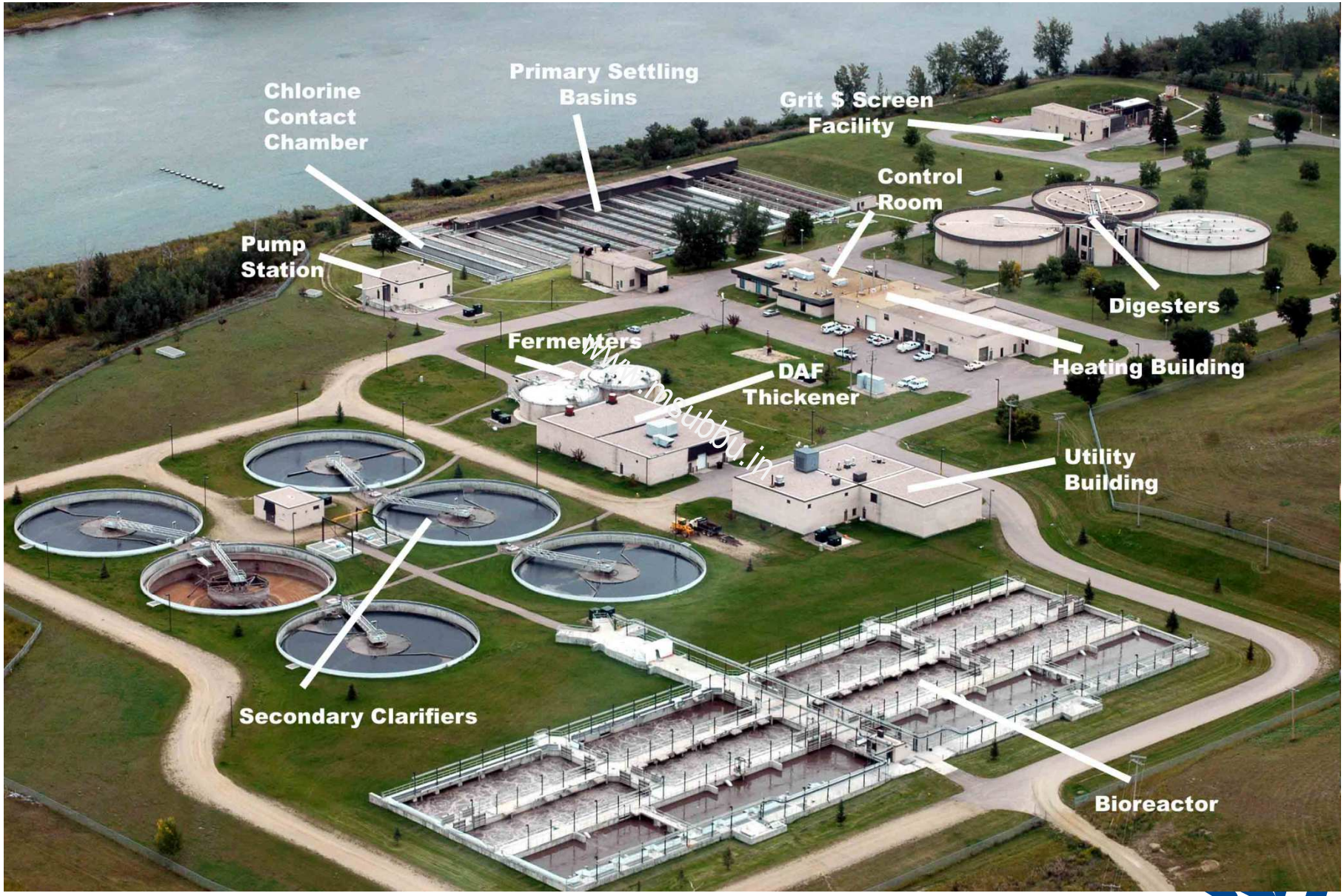
Water Pollutants (contd.)

- **Suspended matter**
  - Some pollutants are *dissolved* in wastewater, meaning that the individual molecules or ions (electrically charged atoms or molecules) of the substance are mixed directly in between the molecules of water. Other pollutants, referred to as *particulate* matter, consist of much larger but still very small particles which are just *suspended* in the water.
  - Although they may be kept in suspension by turbulence, once in the receiving water, they will eventually settle out and form silt or mud at the bottom. These *sediments* can decrease the depth of the body of water. If there is a lot of biodegradable organic material in the sediment, it will become anaerobic and contribute to problems.
  - Toxic materials can also accumulate in the sediment and affect the organisms which live there and can build up in fish that feed on them, and so be passed up the food chain, causing problems all along the way . Also, some of the particulate matter may be grease-- or be coated with grease, which is lighter than water, and float to the

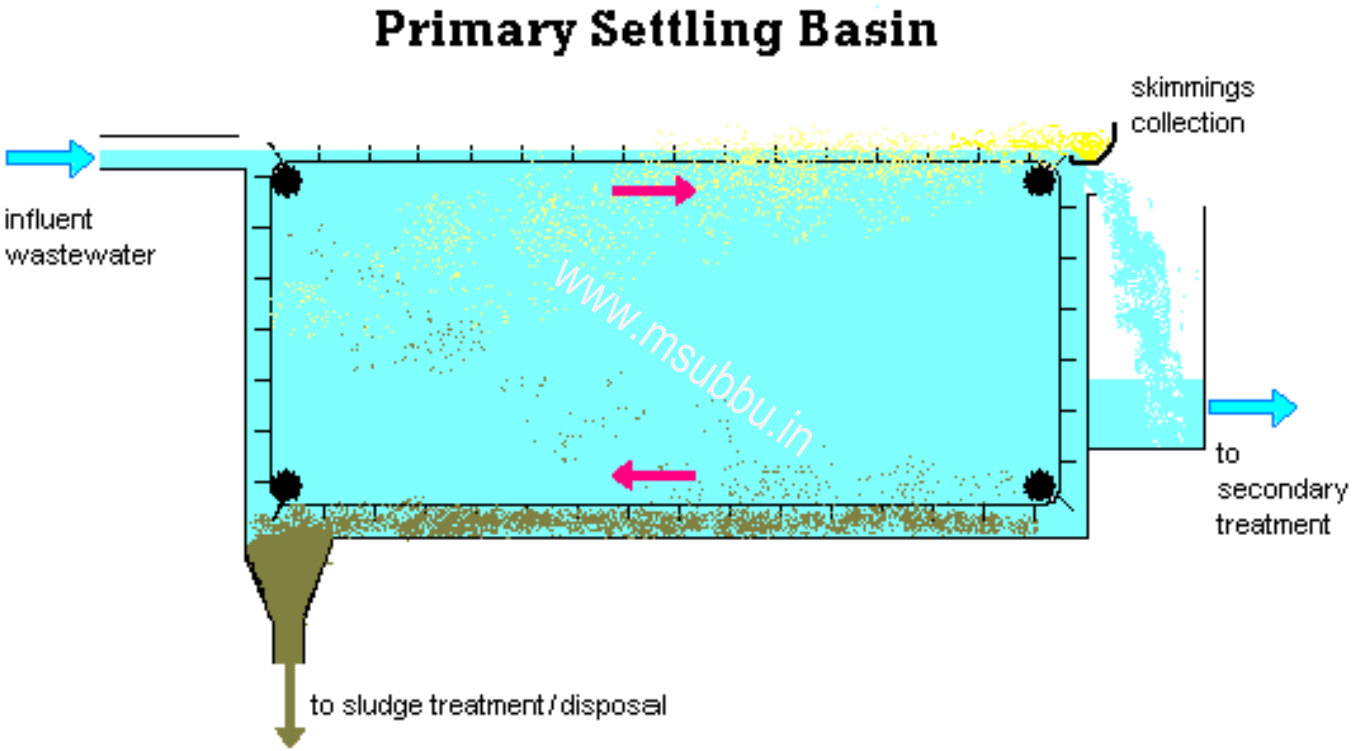
Wastewater Treatment Process



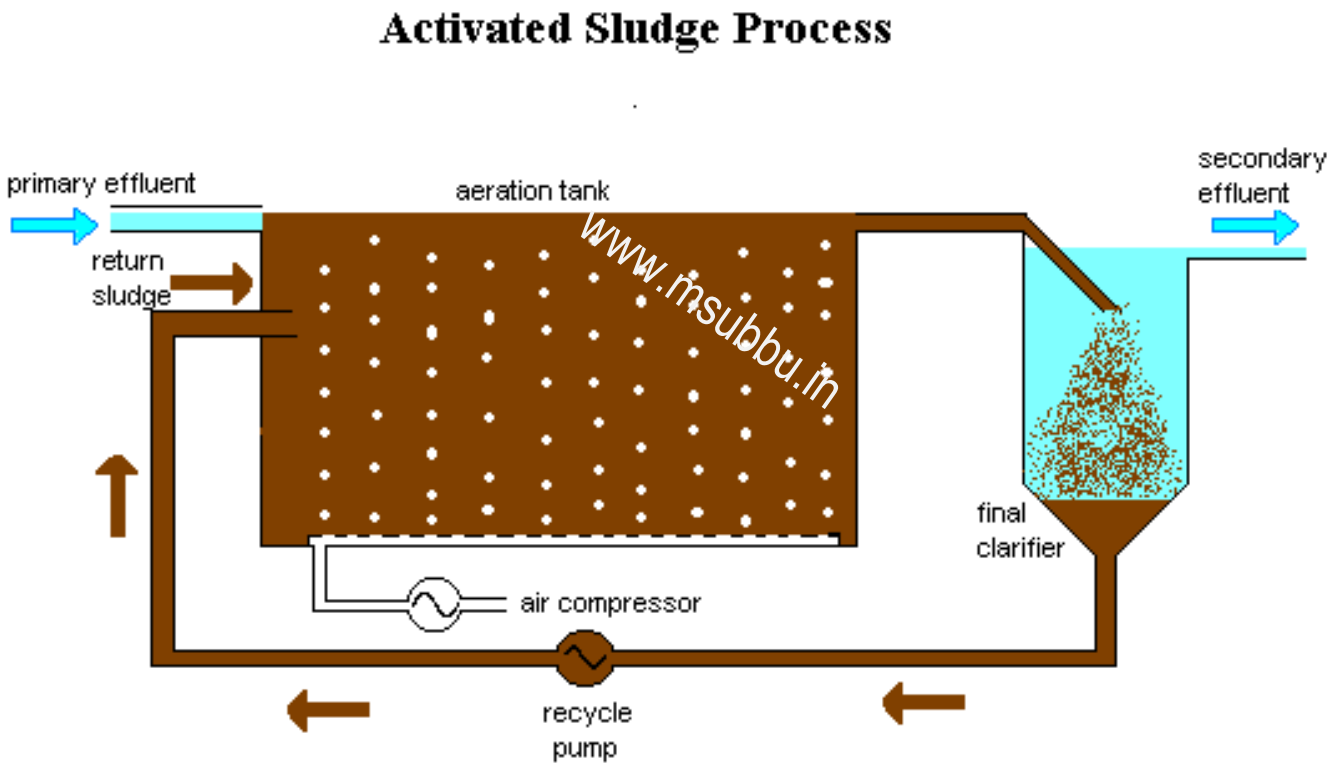

Flow Equalisation
Biological Treatment
Polishing
Mill Process Wastewaters
Primary Clarifier
Inlet Screen
Equalisation Tank
Process Feed Pumps
Secondary Clarifier
Return Sludge
Air
Nutrients
Activated Sludge Tank
Sludge Wasted to Andritz Press
Air
Nutrients
Suspended Carrier Tank
Alum & Polymer
Dissolved Air Flotation Unit
Sludge to Andritz Press
Discharge to Shoalhaven River via Western Drain


Chlorine Contact Chamber
Primary Settling Basins
Grit $ Screen Facility
Control Room
Pump Station
Digesters
Fermenters
DAF Thickener
Heating Building
Utility Building
Secondary Clarifiers
Bioreactor
www.msubbu.in

Primary Treatment Step



Second Treatment Processes



Aerator