Environmental Engineering-1

Lecture 2- Water Pollution

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Overview

- What is Water Pollution?
- Types & Sources of Water Pollution
  - Sewage
  - Sediment pollution
  - Thermal pollution
  - Agriculture & Industrial
- Principal Pollutants & Effects
- Approach to control pollution
- Improving Water Quality
- Drinking water quality assessment

Water Pollution

"Any chemical, biological, or physical change in water quality that has a harmful effect on human health , living resources, hindrance to aquatic activities such as fishing, impairment of water quality with respect to its use in agriculture, industrial & other economic activities, & reduction in amenities."

Major water pollution issue globally

- Lack of disease-free water

Types of Water Pollution

- ✓Surface Water Pollution
- ✓Ground Water Pollution
- ✓Oxygen depleting
- ✓Nutrient
- ✓Microbiological
- ✓Suspended matter
- ✓Chemical

http//: www.eschooltoday.com/pollution/water-pollution

Sewage

- The release of wastewater from drains or sewers
  - Includes human wastes, soaps, and detergents
- Causes 2 serious environmental problems:
  - Enrichment
    - Fertilization of a body of water by high levels of plant and algal nutrients (nitrogen and phosphorus)
  - Increase in Biological Oxygen Demand (BOD)
    - Amount of oxygen needed by microorganisms to decompose biological wastes
    - As BOD increases Dissolve Oxygen (DO) decreases

What are the sources of Water Pollution?

- Mainly there are two sources of water pollution

1- Natural Sources

2- Anthropogenic Sources

- Natural sources includes; storm water and agricultural runoff
- Anthropogenic sources includes; municipal, industrial etc.

Other sources

- We can also categories water pollution with respect to the discharge

1- Point Source

2- Non-Point Source

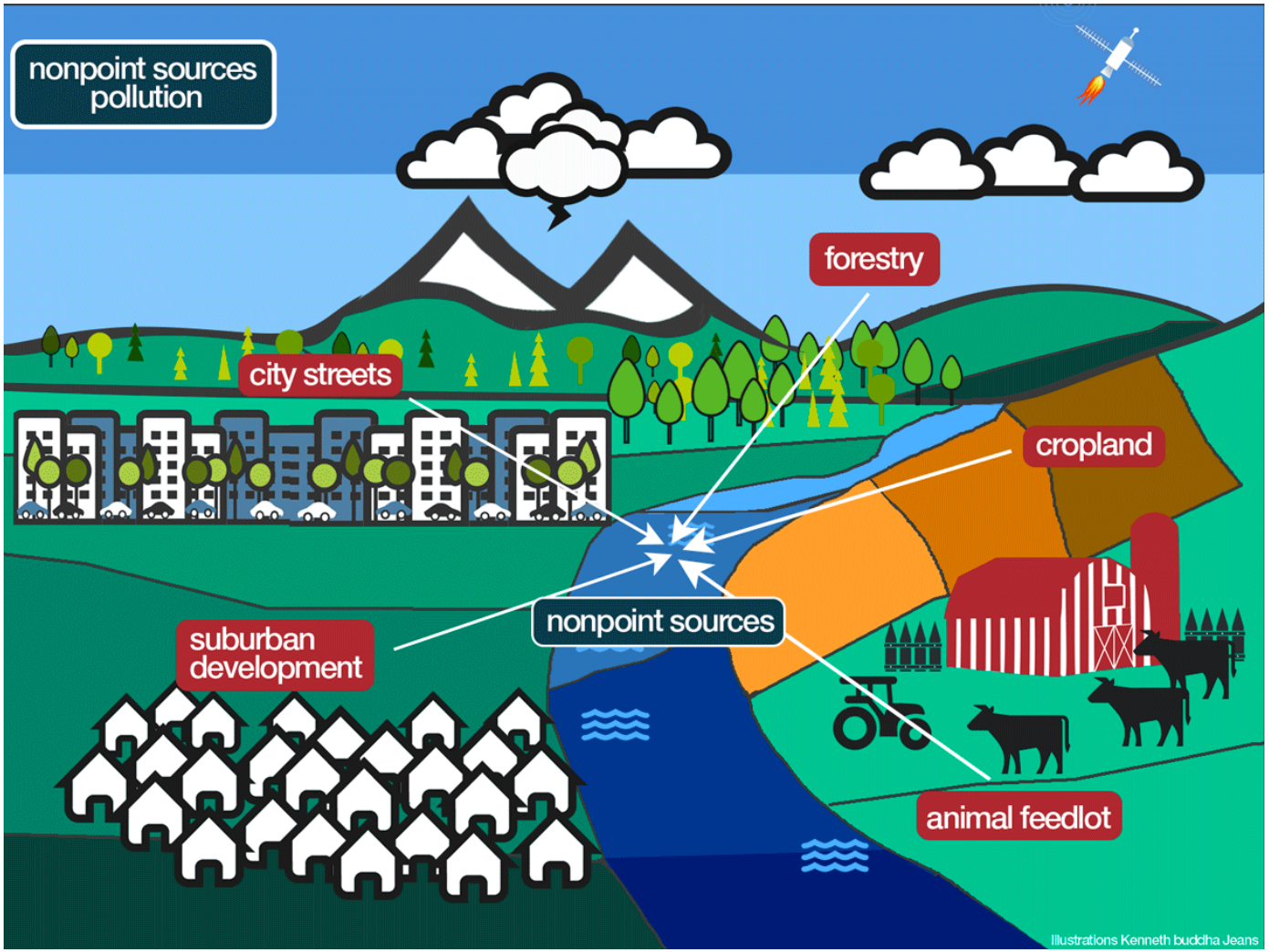
Point Source(Direct)

- Point source of water pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch.
- Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain

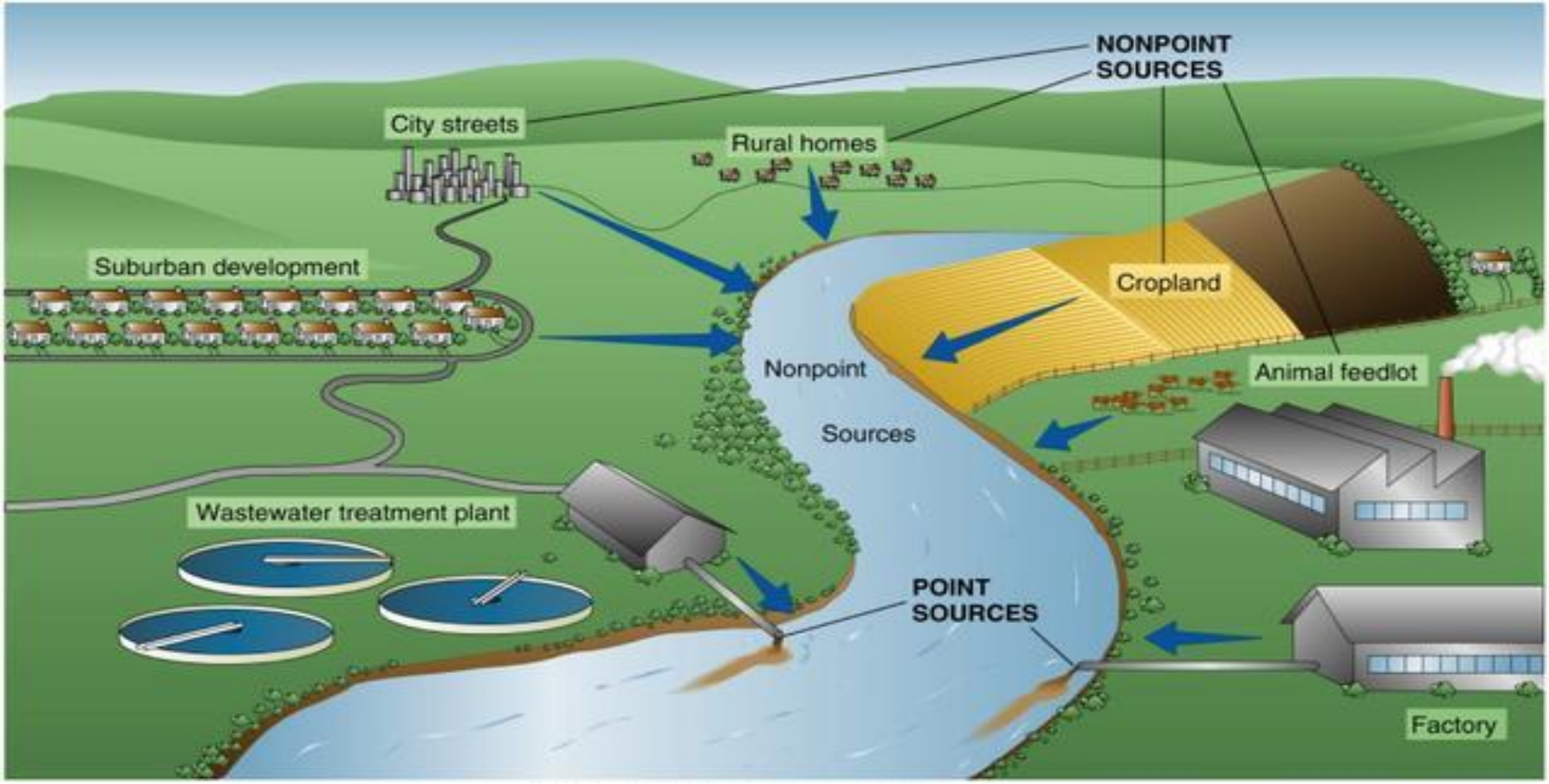
Sources of water pollution

- **Non-Point Source(Indirect)**
- Nonpoint source of water pollution refers to diffuse contamination that does not originate from a single discrete source.
- These are scattered or diffused having no specific location of discharge .
- It is often the cumulative effect of small amounts of contaminants gathered from a large area.
- Examples are; leaching out of nitrogen compounds from fertilized agricultural lands. Nutrient runoff in storm water , urban runoff
- Rain water often carry oil, grease, dirt, trash, animal waste etc. to receiving water bodies.

Non Point sources of Water Pollution



Point & Non point Sources



Principle Water Pollutants

Generally water pollutants can be divided into eight categories.

1- Pathogens: Diseases causing agents

2- Oxygen demanding waste

3- Inorganic Chemicals

4- Inorganic Plant Nutrients

5- Organic Chemicals

6- Sediments and suspended matter

7- Radioactive substances

8- Heat

Principle Water Pollution

A. Natural source:

- Storm water Runoff

Pollutants	Impacts
Sediments	❑Turbidity, ❑Reduced photosynthesis, ❑Clogging of fish gills, ❑Adherence of toxic compounds/pathogens on soil particles

Water pollutants

B. Anthropogenic source:

- Municipal
- Industrial
- Agricultural

Municipal Pollutants	Industrial Pollutants	Agricultural Pollutants
❑Organic matter ❑Nutrients ❑pathogens	❑Detergents ❑Solvents ❑Heavy metals ❑Oil ❑Dyes ❑Phenol compound ❑Salts ❑Acids ❑Alkalis ❑Bleaching agents ❑Pathogens	❑Nutrients ❑Pesticides ❑Sediments

- **Major Categories of Pollutants**

CAUSES HEALTH PROBLEM

Category	Example	Sources
Infectious agents	Bacteria, virus, worms	Human /animal extract
Organic chemicals	Pesticides, plastics, detergents, oils	Industrial, household, farm use
Inorganic chemicals	Acids, caustic salts, metals	Industrial effluent, household cleanser, runoff

CAUSES ECOSYSTEM DISRUPTION

Category	Example	Sources
Sediments	Soil, silt	Land erosion
Plant nutrients	NO_2,PO_4,NH_4	Agriculture fertilizer sewage, sludge
Oxygen demanding wastes	Animal & human feces, plant residues	Sewage, agricultural runoff, paper mills& many industrial wastes.
Thermal	Heat	Power plants, cooling water

- **Major Categories of Pollutants**

Impacts of some organic pollutants on Health	
Aldecarb (Pesticides)	Attacks nervous system
Benzene (Solvent)	Blood disorders, Lekumia
CCl4 (Solvent)	Cancer , liver & kidney damage
PCB3 (Industrial chemical)	Cancer , liver & kidney damage
CHCl3 (Chloroform)	Cancer
Dioxins, Furons (Volatile compd)	Cancer
DDT	Poisonous ,affects reproduction

*PCBS: Polychloinated biphenyles

**DDT: Dichlorodiphenyltrichloroethane.

Effects on Health through Aquatic Food

- Fish accumulate toxic element such as mercury, cadmium, and polycyclic hydrocarbon

Chemical	Source	Disease
Hg	Methyl mercury	Minamata disease(brain damage, death)
Cd		Joint disease
Polycyclic HC	From oil pollution	Potential carcinogen
Polychlorinated Biphenyles (PCBs)	Plasticizers lubricants	Liver damage, carcinogen

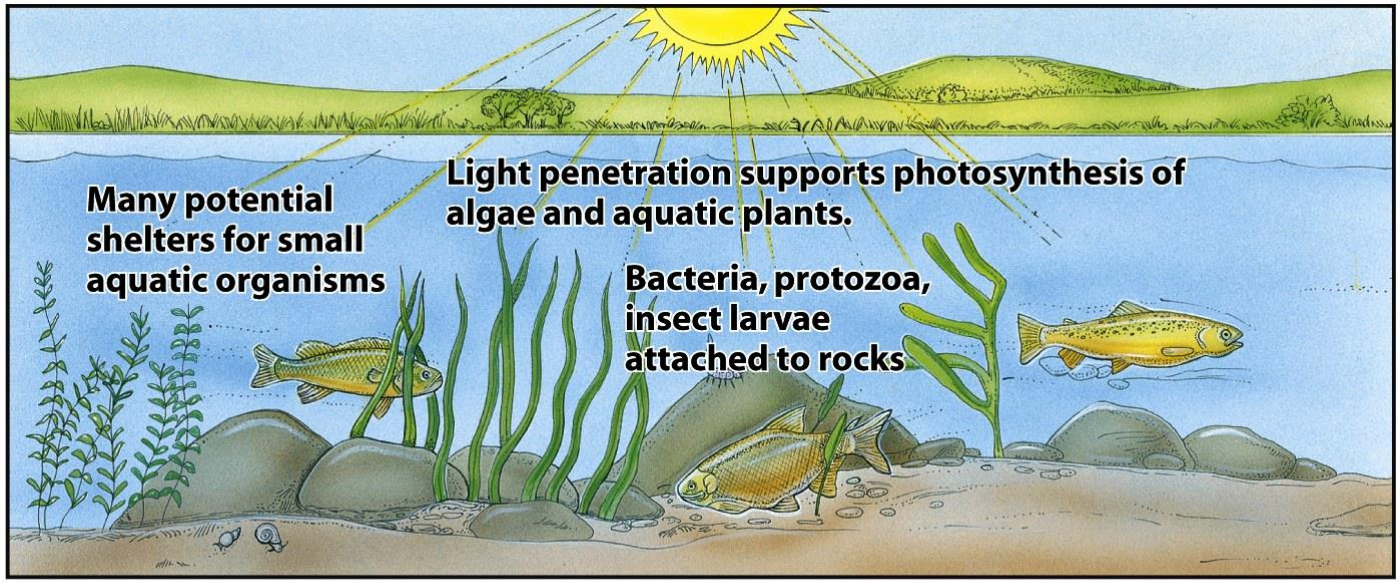
Sediment Pollution

Sediment Pollution

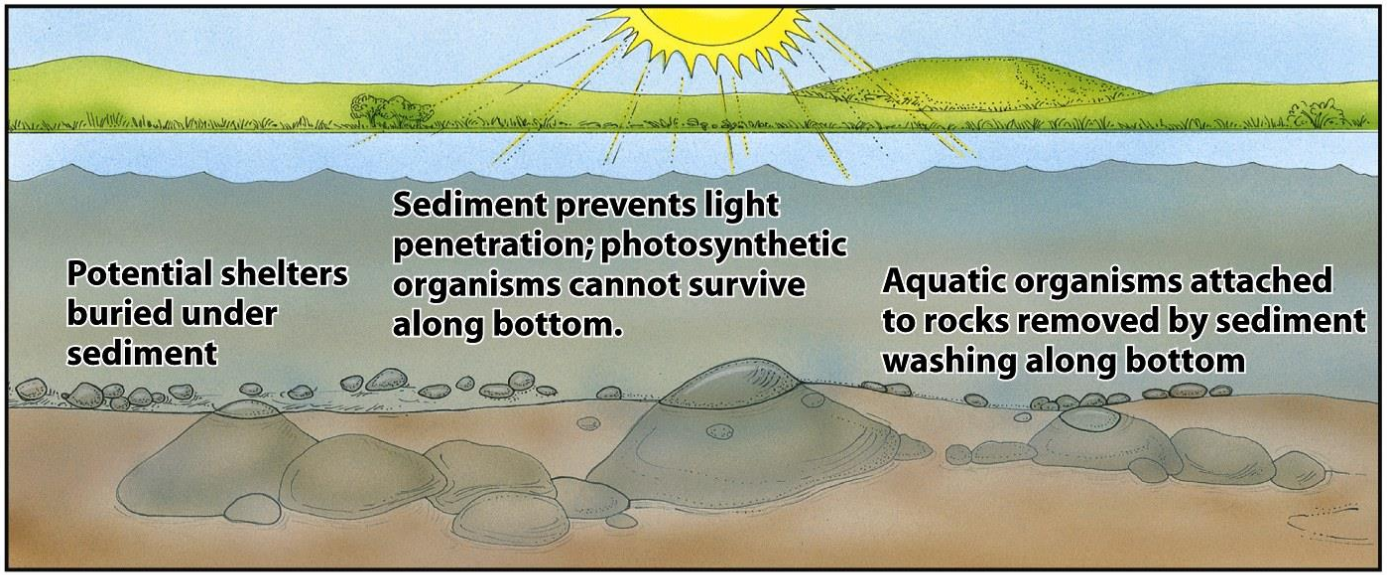
- Excess of sedimentation
  - Originates from erosion of agricultural lands, forest soils exposed by logging (cutting of trees), degraded stream banks, overgrazed (land with scrat hes) rangelands, strip mines, and construction

- Problems
  - Limits light penetration
  - Covers aquatic animals and plants
  - Brings insoluble toxins (poisonous substance) into waterways

Sediment Poluution



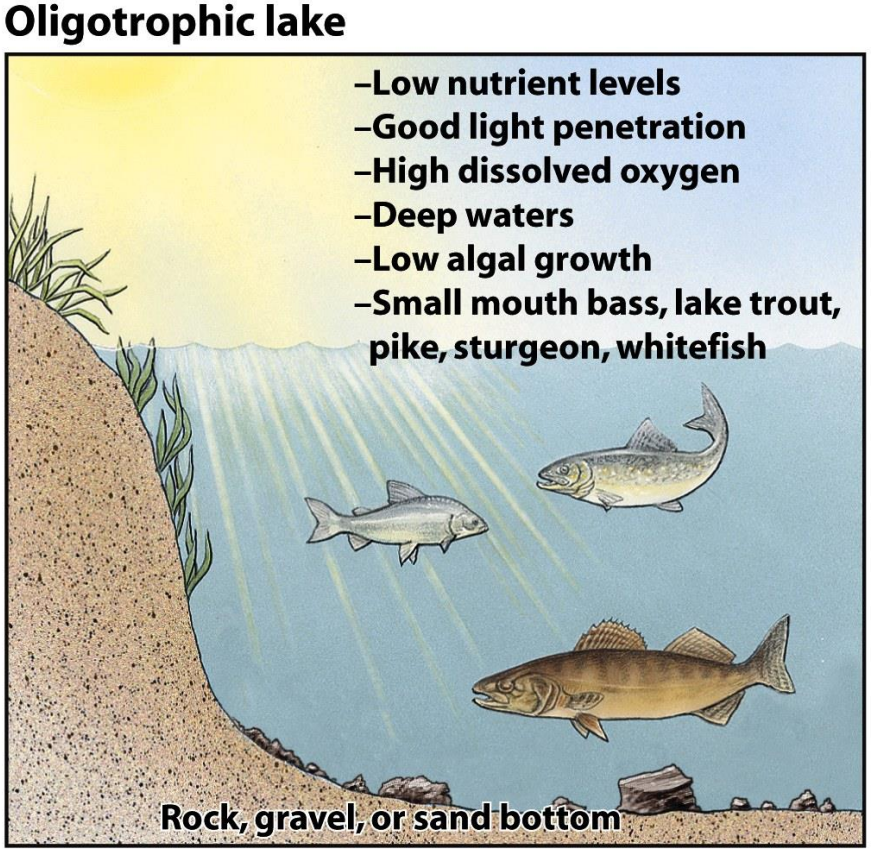
Stream ecosystem with low level of sediment



Same stream with high level of sediment

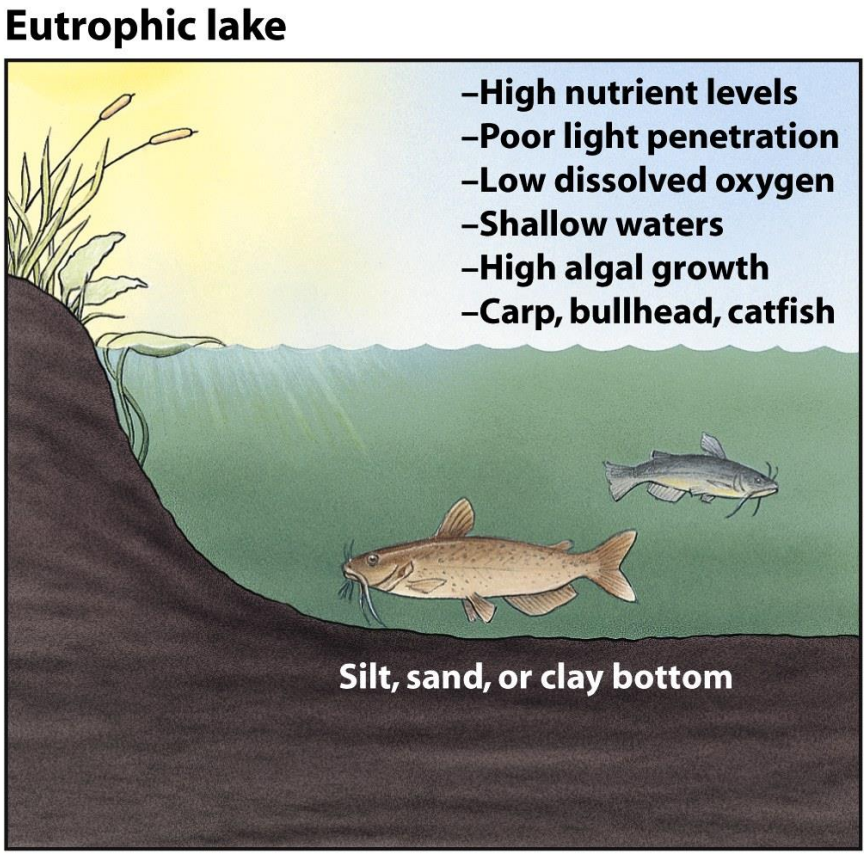
Sewage- Eutrophication (Excessive Nutrients)

- **Oligotrophic**
  - Unenriched, clear water that supports small populations of aquatic organisms



- **Sewage- Eutrophication**
- **Eutrophic**
  - Slow-flowing stream, lake or estuary enriched by inorganic plant and algal nutrients such as phosphorus
  - Often due to fertilizer or sewage runoff

coastal water body



Excess of Nutrients and Dead Zones

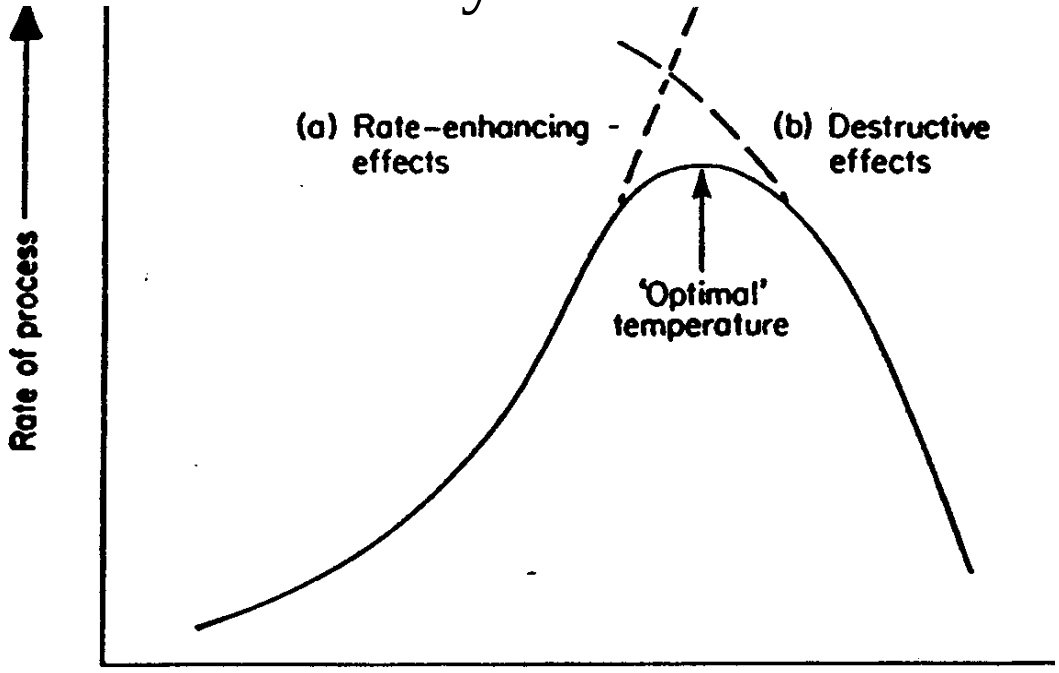
Thermal Pollution

Thermal Pollution

- Caused by the release of waste heat into water or air.
- Electric power plants are a major source of thermal pollution. In these plants, only about one third of the energy in the fuel is converted into electricity, and the remaining energy is released as heat to the local environment
- The entrance of this waste heat into the environment may have serious consequences

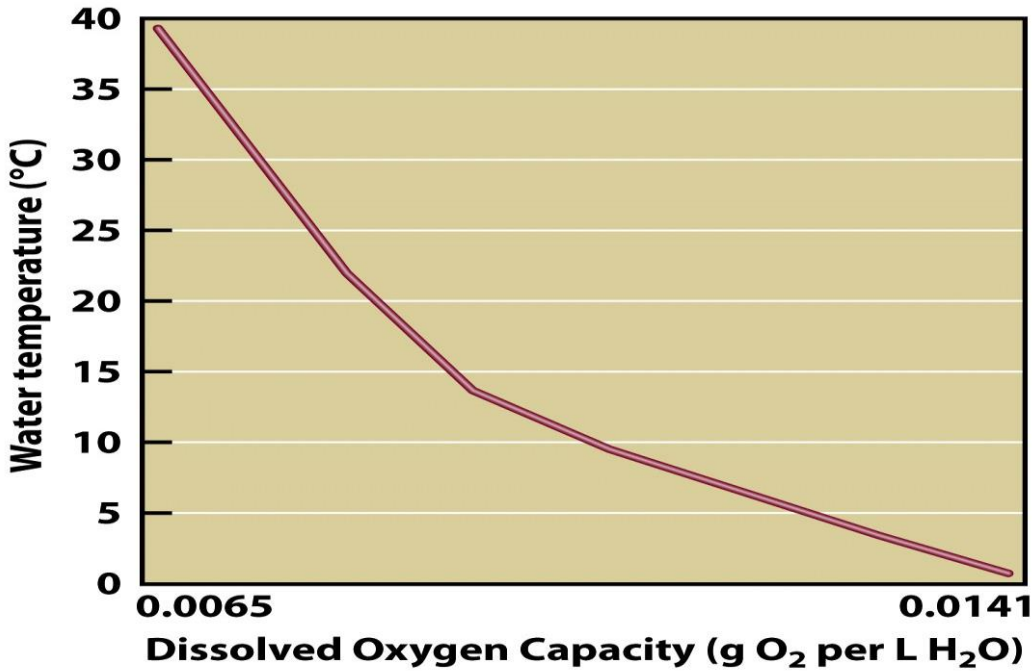
Effect

- Heat introduced into water can make the water so hot that no living thing can survive in it. In water above 140° F (60° C) it is very unusual for algae or bacteria to live, and serious problems occur at even much lower temperature levels. The resulting thermal stress may be lethal to some species.



Effect

- Higher temperature increases oxygen consumption by fish and other organisms.
- Higher temperature lowers the oxygen-carrying capacity of water. Thus, smaller amounts of oxygen are available just when oxygen need is increasing.



Agricultural Water Pollution

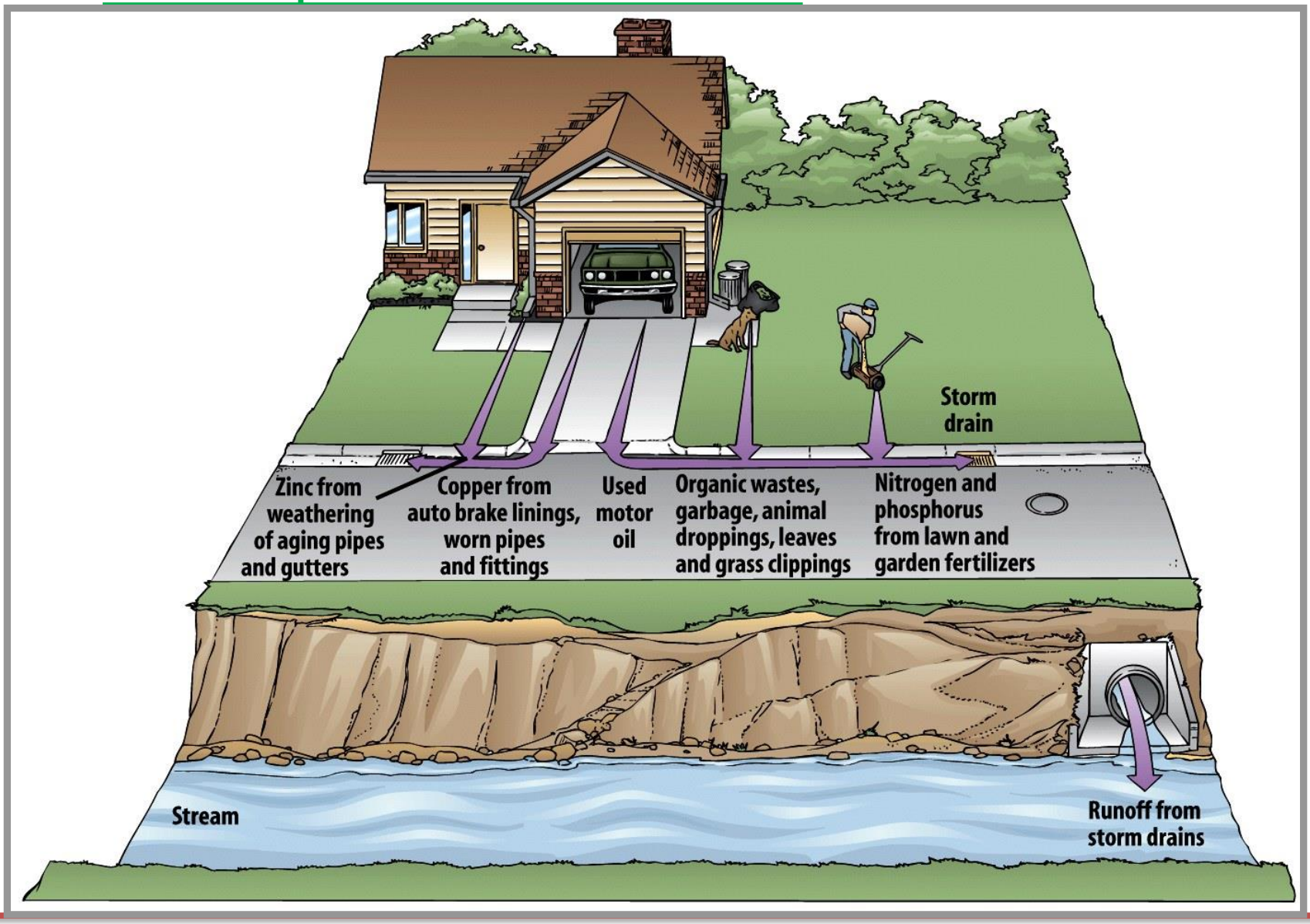
Agriculture & Water Pollution

- Agriculture contributes a major economic portion of Pakistan
  - Animal wastes and plants residues have high BOD (Bio-chemical Oxygen Demand)
  - Chemical pesticides can leach into groundwater

Municipal Water Pollution

Municipal water pollution

- Municipal Water Pollution



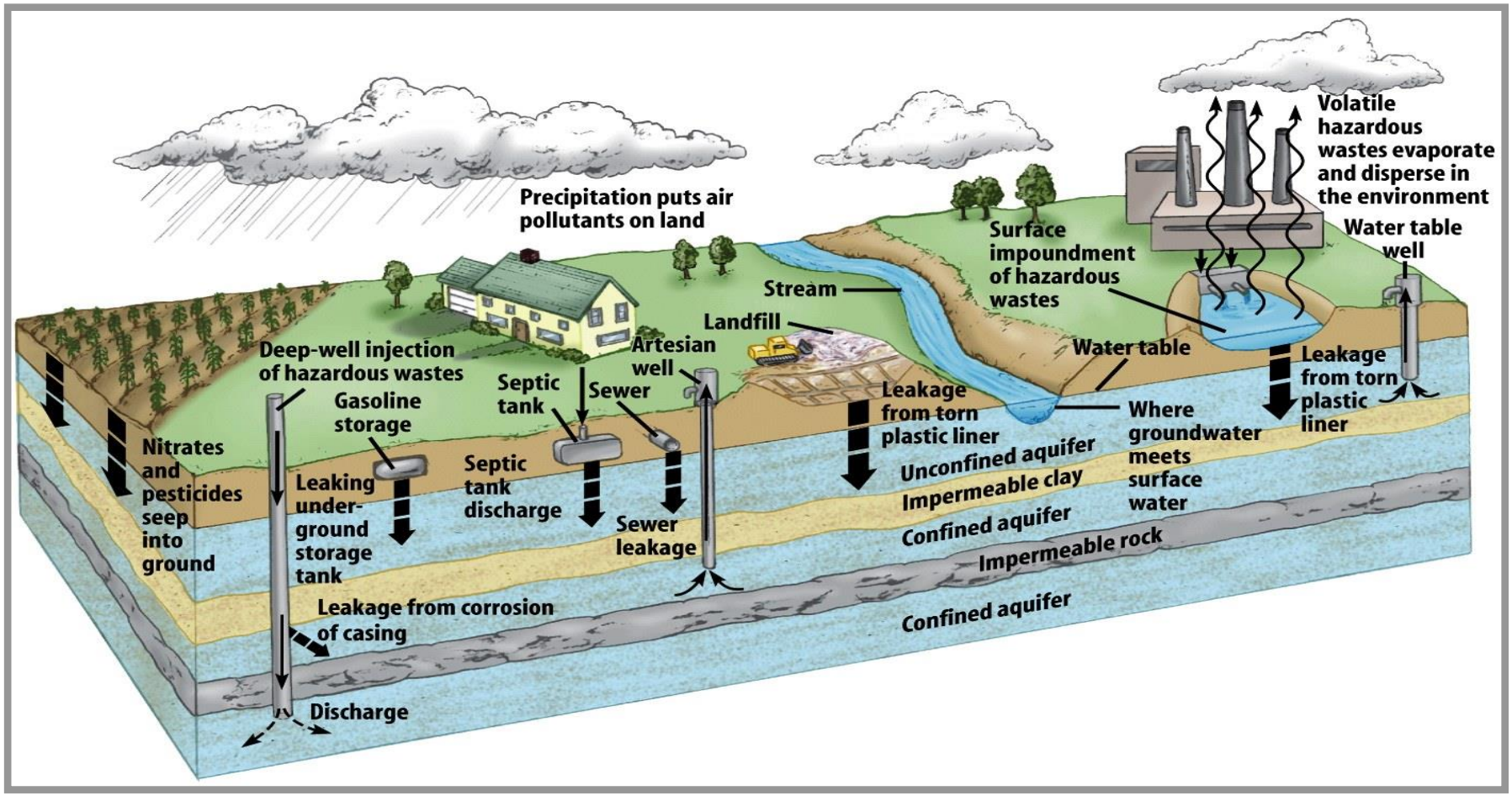
Industrial Wastes in Water

Industrial Wastes in Water

- Different industries generate different pollutants
  - Food processing plants- high BOD
  - Paper mills- High BOD and toxic compounds

Ground Water Pollution

- **Groundwater Pollution**



General Measures of Water Pollution Control

1.Adopt pollution prevention approaches

- Use cleaner production technologies in industrial processes
- Employ good housekeeping in industries
- Reuse wastes, recover materials
- Use natural fertilizers in place of synthetics
- Use less pesticides

2. Treat wastewater

- Physical, chemical, biological methods

General Measures of Water Pollution Control

3.Entact pollution control legislation

- Pakistan Environmental Protection Act (1997)
- National Environmental Quality Standards (NEQS)
- Pollution charges

4.Enhance public awareness

Improving Water Quality- Purification of Drinking Water

Improving water quality

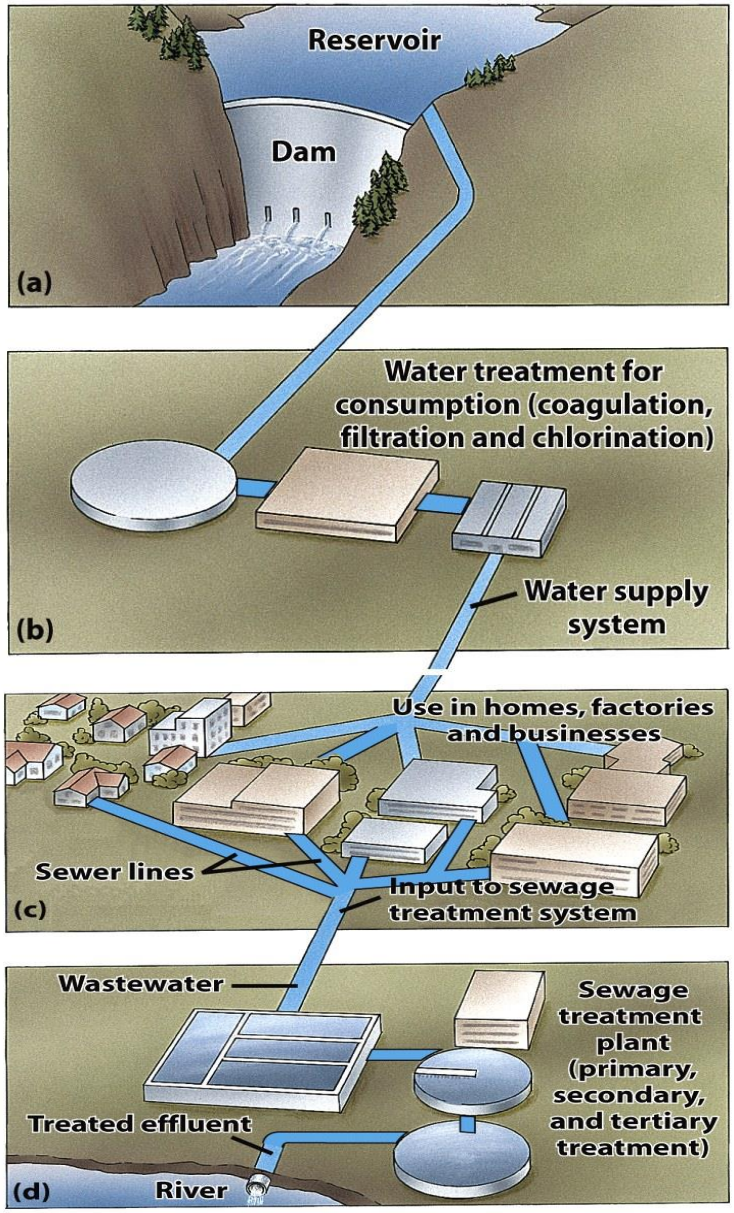
Collect Water in reservoir

Transfer water to Water Treatment Plant

Treated water distributed to consumer

Sewer lines bring sewage to Wastewater Treatment Plant

Wastewater is treated in Wastewater treatment plant and treated water is discharged to receiving streams



Drinking Water Quality

- Ensuring the safety of drinking water ; Water safety plans are made; which ensures

1. System Assessment (determine whether water supply chain can deliver water of a quality that meets health based targets)

2. Operational and monitoring(identify performance parameters then monitor them)

3. Management Plans(all actions taken during normal operation)

Approach for safety of drinking water

Know your Water Quality(from Source)

Water Treatment (if required)

Protection of distribution system

Safe Drinking water