Water Pollution

Overview

- Types of Water Pollution
  - Sewage
  - Disease-causing agents
  - Sediment pollution
  - Inorganic plant and algal nutrients
  - Organic compounds
  - Inorganic chemicals
  - Thermal pollution
- Water Quality Today
- Improving Water Quality
- Laws Controlling Water Pollution

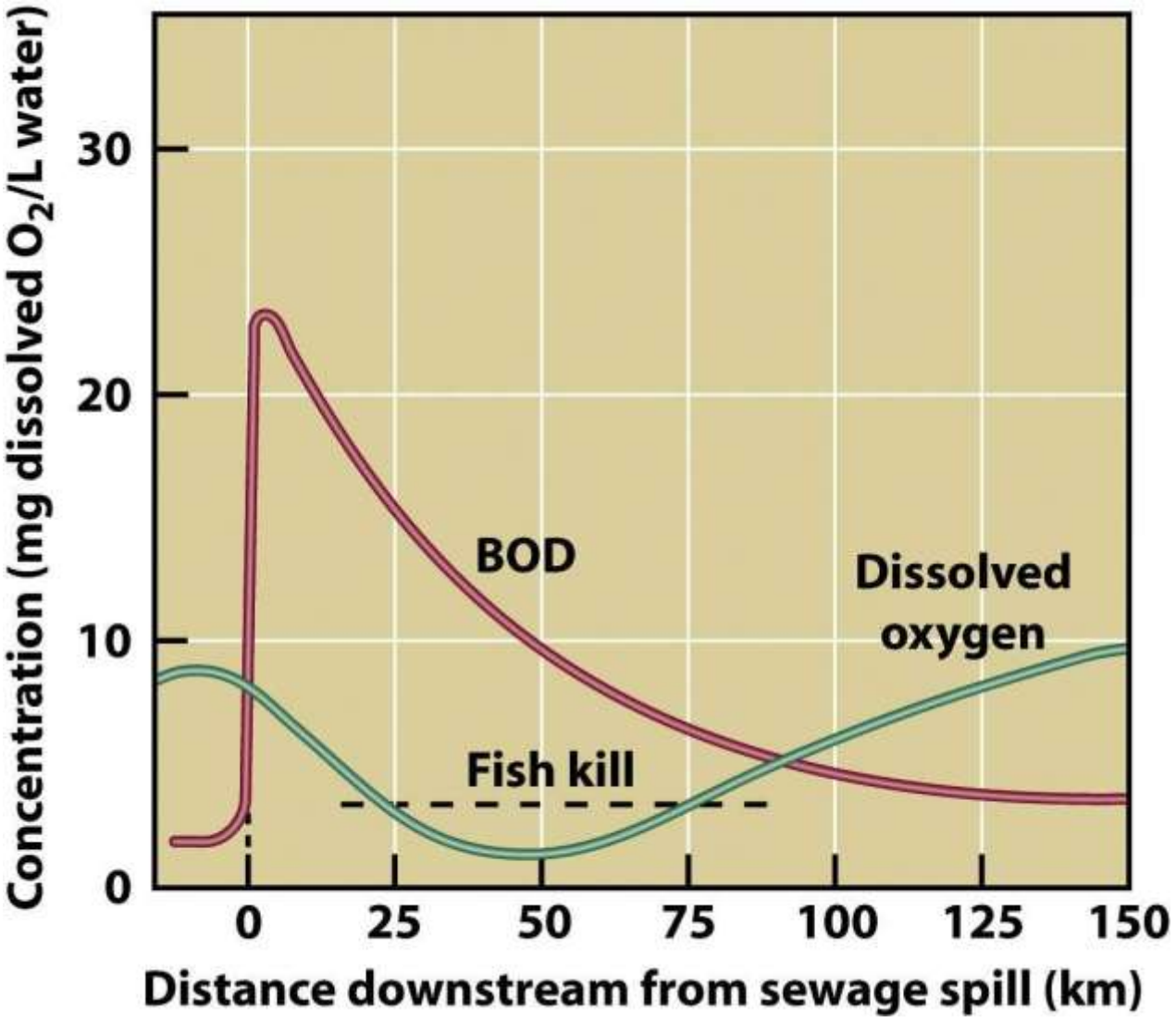
Types of Water Pollution

- Water pollution
  - Any physical or chemical change in water that adversely affects the health of humans and other organisms
  - Varies in magnitude by location
- Major water pollution issue globally
  - Lack of disease-free water
- Eight categories
  - Sewage, disease-causing agents, sediment pollution, inorganic plant and algal nutrients, organic compounds, inorganic chemicals, radioactive substances, and thermal pollution

Sewage

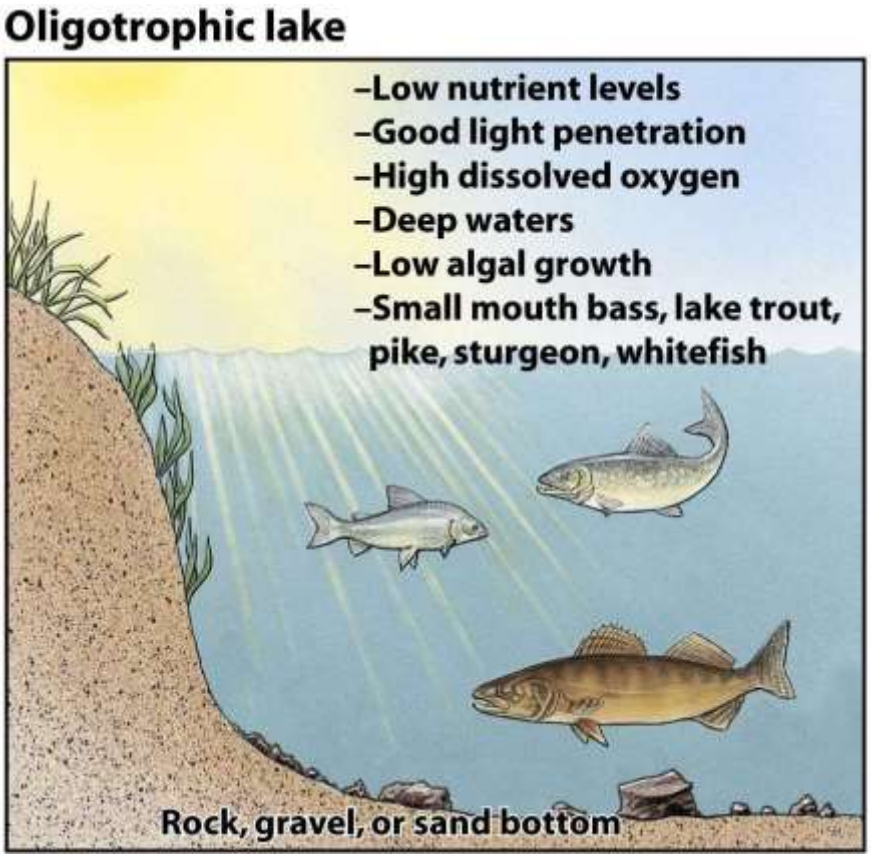
- The release of wastewater from drains or sewers
  - Includes human wastes, soaps, and detergents
- Causes 2 serious environmental problems:
  - Enrichment
    - Fertilization of a body of water by high levels of plant and algal nutrients (nitrogen and phosphorus)
  - Increase in Biological Oxygen Demand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

Sewage


Concentration (mg dissolved O_2/L water)
30
20
10
0
BOD
Dissolved oxygen
Fish kill
0
25
50
75
100
125
150
Distance downstream from sewage spill (km)

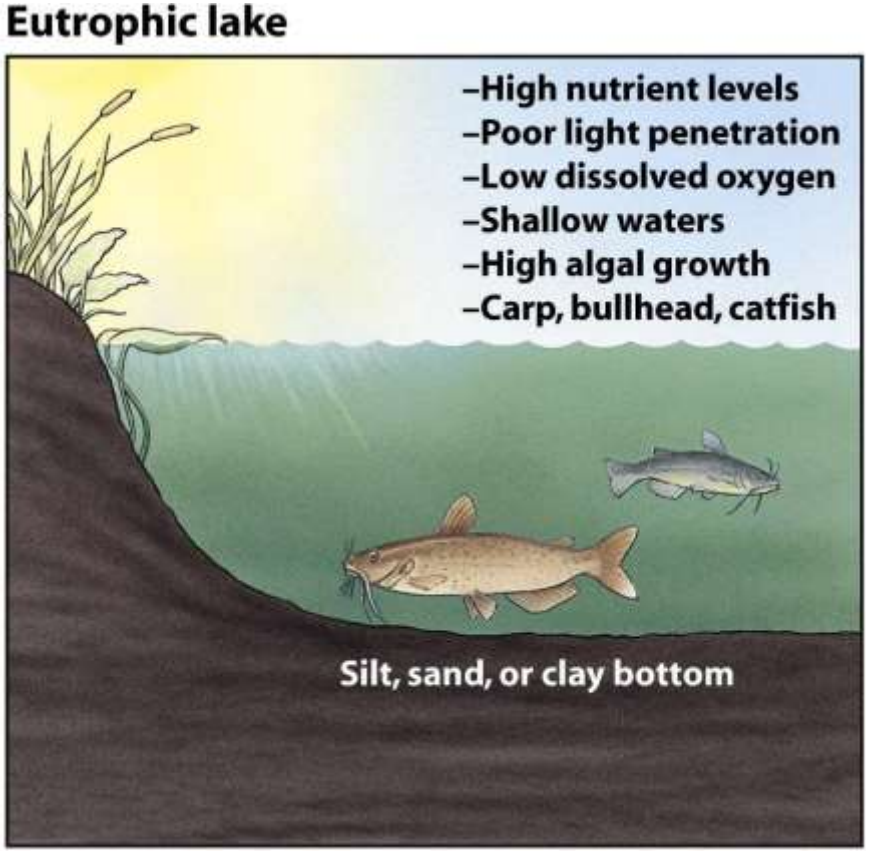
Sewage- Eutrophication

- 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



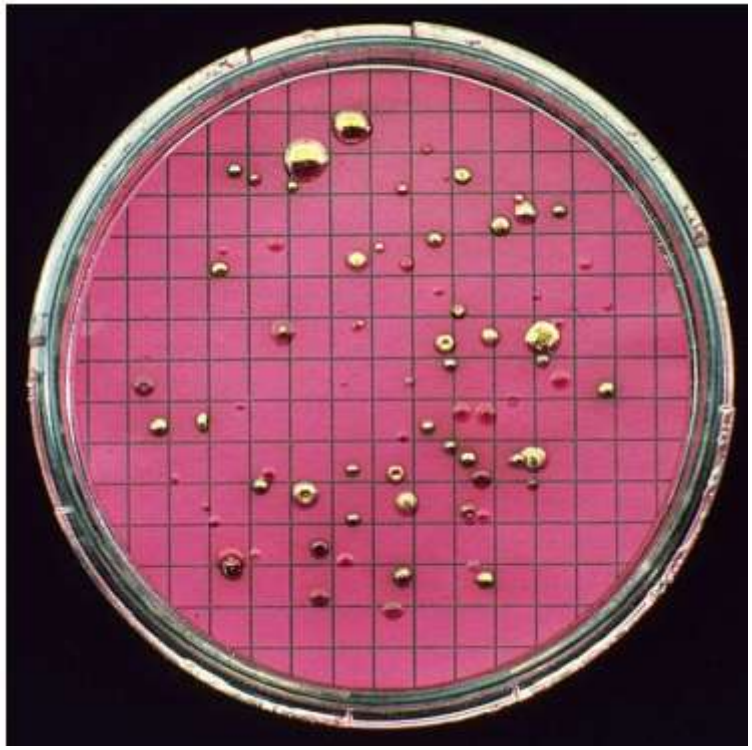
Disease-causing Agents

- Infectious organisms that cause diseases
  - Originate in the wastes of infected individuals
- Common bacterial or viral diseases:
  - Typhoid, cholera, bacterial dysentery, polio, and infectious hepatitis

Disease	*Infectious Agent*
Cholera	*Vibrio cholerae*
Dysentery	*Shigella dysenteriae*
Enteritis	*Clostridium perfringens,* other bacteria
Typhoid	*Salmonella typhi*
Infectious hepatitis	Hepatitis virus A
Poliomyelitis	Poliovirus
Cryptosporidiosis	*Cryptosporidium* sp.
Amoebic dysentery	*Entamoeba histolytica*
Schistosomiasis	*Schistosoma* sp.
Ancylostomiasis	*Ancylostoma* sp.

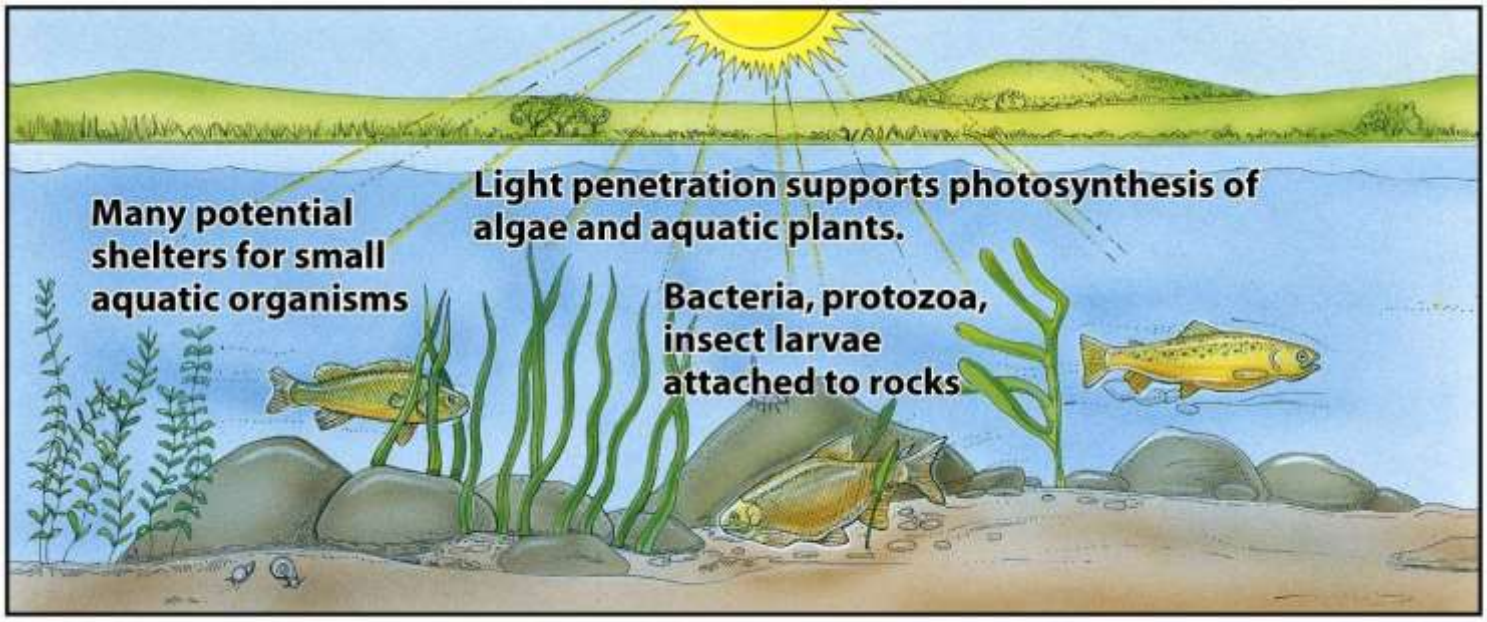
Disease-causing Agents

- Monitored by testing for presence of E. coli in the water via a f ecal coliform test
  - Indicates the presence of pathogenic organisms

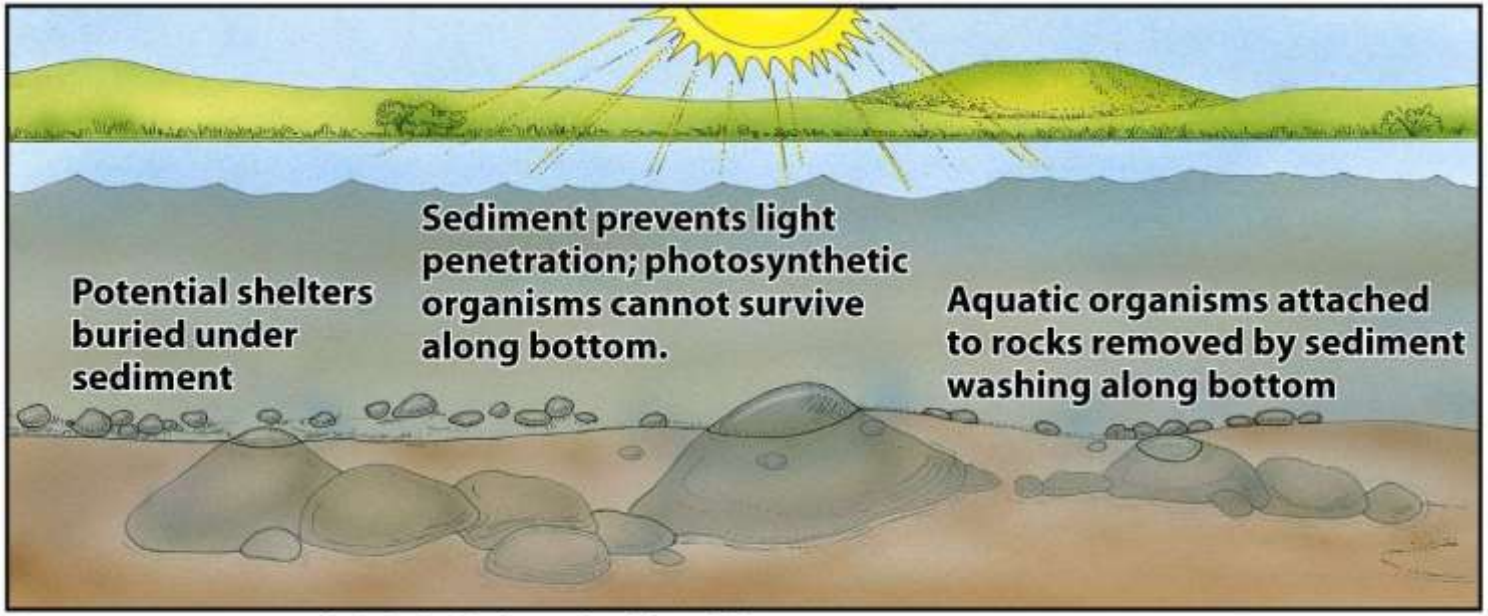


Sediment Pollution

- Excessive amounts of suspended soil particles
  - Originates from erosion of agricultural lands, forest soils exposed by logging, degraded stream banks, overgrazed rangelands, strip mines, and construction
- Problems
  - Limits light penetration
  - Covers aquatic animals and plants
  - Brings insoluble toxins into waterways



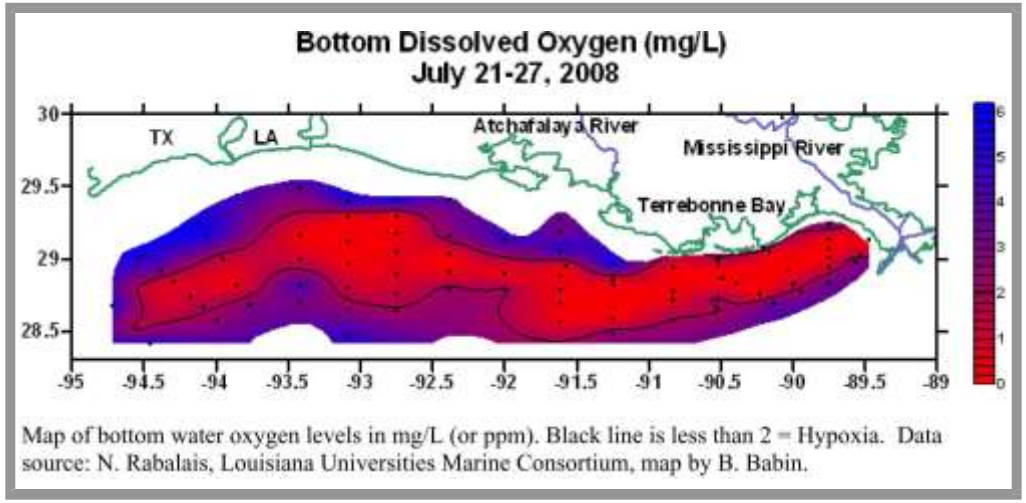
Stream ecosystem with low level of sediment



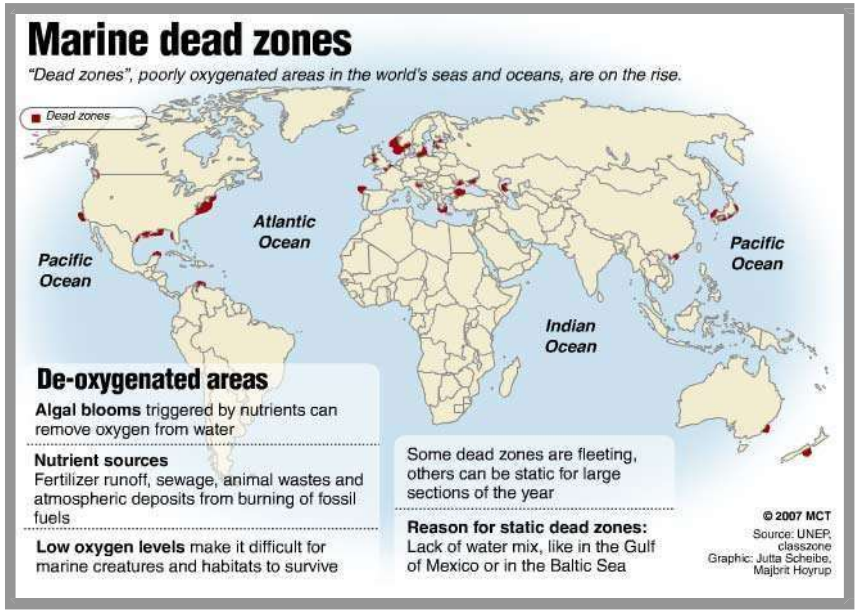
Same stream with high level of sediment

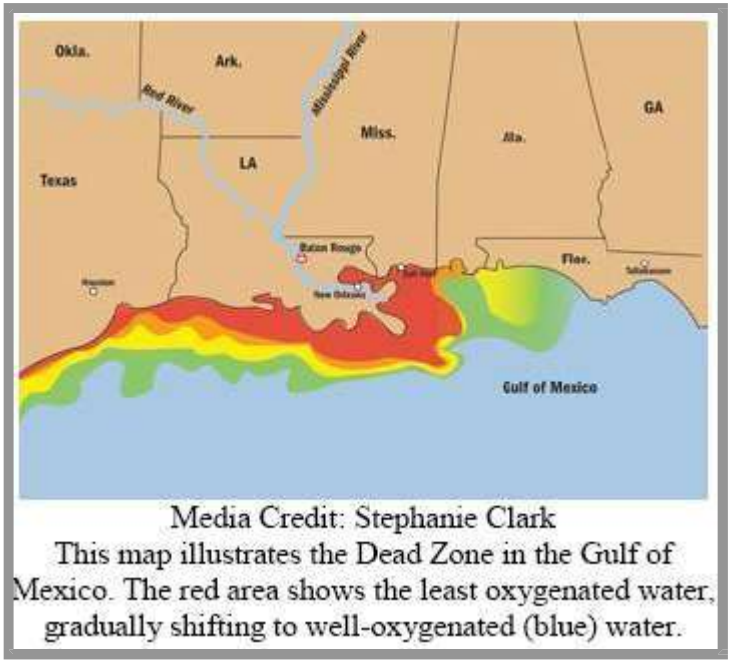
Inorganic Plant and Algal Nutrients

- Chemicals such as nitrogen and phosphorus that stimulate the growth of plants and algae
  - Harmful in large concentrations
- Sources:
  - Human and animal wastes, plant residues, atmospheric deposition, and fertilizer runoff
- Causes:
  - Enrichment, bad odors, and a high BOD



Map of bottom water oxygen levels in mg/L (or ppm). Black line is less than 2 = Hypoxia. Data source: N. Rabalais, Louisiana Universities Marine Consortium, map by B. Babin.





Media Credit: Stephanie Clark
This map illustrates the Dead Zone in the Gulf of Mexico. The red area shows the least oxygenated water, gradually shifting to well-oxygenated (blue) water.

Organic Compounds

- Chemicals that contain carbon atoms
  - Natural examples: sugars, amino acids, and oils
  - Human-made examples: pesticides, solvents, industrial chemicals, and plastics

Table 22.2 Some Synthetic Organic Compounds Found in Polluted Water

Compound	*Some Reported Health Effects*
Aldicarb (pesticide)	Attacks nervous system
Benzene (solvent)	Associated with blood disorders (bone marrow suppression); leukemia
Carbon tetrachloride (solvent)	Possibly causes cancer; liver damage; may also attack kidneys and vision
Chloroform (solvent)	Possibly causes cancer
Dioxins (TCDD) (chemical contaminants)	Some cause cancer; may harm reproductive, immune, and nervous systems
Ethylene dibromide (EDB) (fumigant)	Probably causes cancer; attacks liver and kidneys
Polychlorinated biphenyls (PCBs) (industrial chemicals)	Attack liver and kidneys; possibly cause cancer
Trichloroethylene (TCE) (solvent)	Probably causes cancer; induces liver cancer in mice
Vinyl chloride (plastics industry)	Causes cancer

Inorganic Chemicals

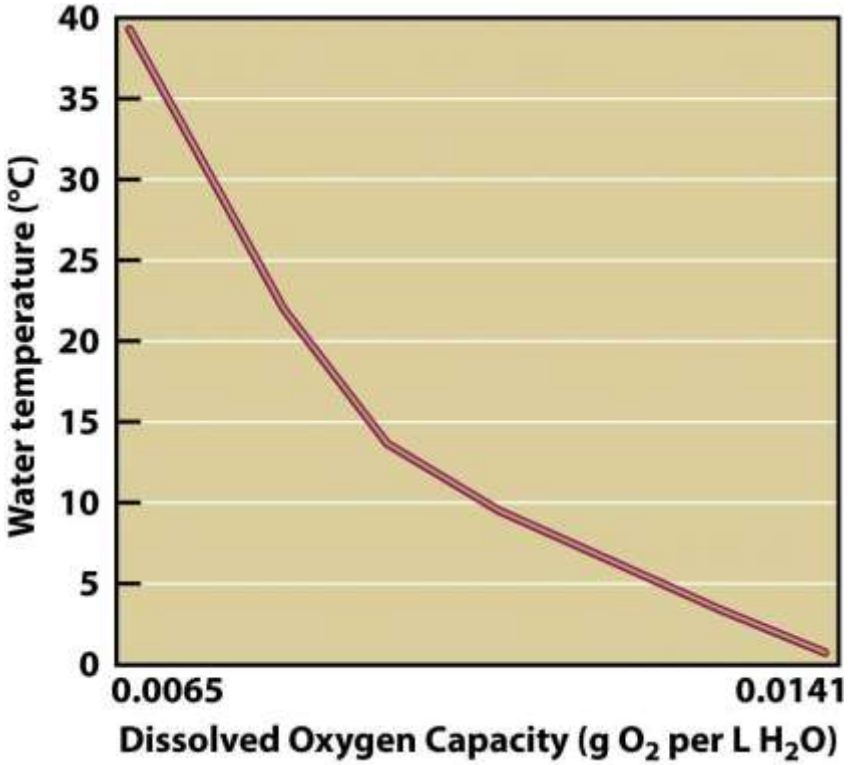
- Contaminants that contain elements other than carbon
  - Examples: acids, salts, and heavy metals
- Do not degrade easily
- Lead
  - Found in old paint, industrial pollutants, leaded gasoline
- Mercury
  - Mercury bioaccumulates in the muscles of top predators of the open ocean

Radioactive Substances

- Contain atoms of unstable isotopes that spontaneously emit radiation
- Sources
  - Mining
  - Processing radioactive materials
  - Nuclear power plants
  - Natural sources

Thermal Pollution

- Occurs when heated water produced during industrial processes is released into waterways
- Organisms affected
  - Temperature affects reproductive cycles, digestion rates, and respiration rates
  - Warm water holds less DO than cold water



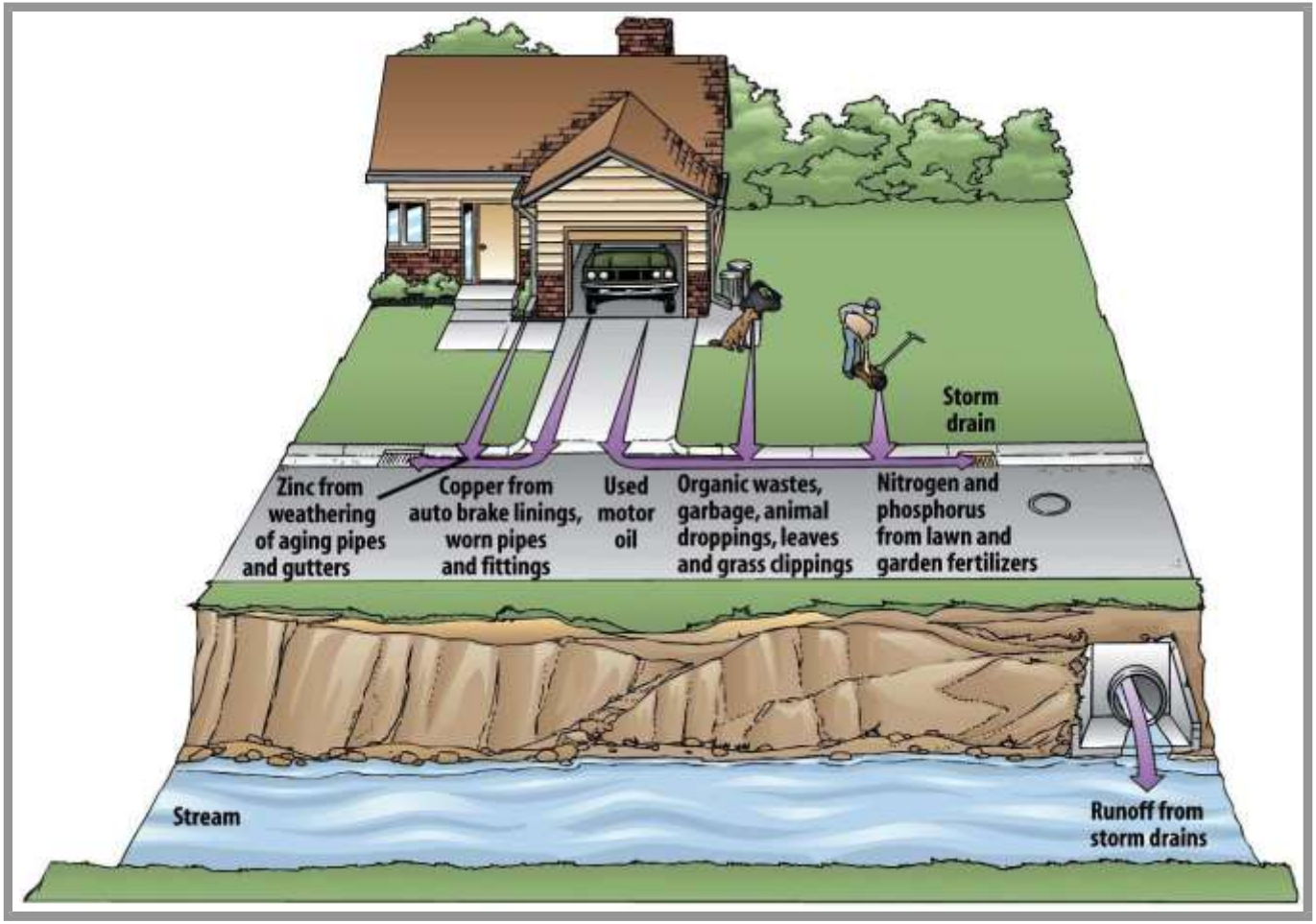
Water Quality Today

- Two Types of Water Pollution
- -Point Source Pollution
  - water pollution that can be traced to a specific origin
  - Discharge via pipes, sewage, and ditches
- -Non-point Source Pollution
  - Pollutants that enter bodies of water over large areas rather than being concentrated at a single point of entry
  - Diffuse, but its cumulative effect is very large
  - Ex: runoff from agricultural fields or parking lots

Water Pollution from Agriculture

- Agriculture is leading source of water pollution in US
  - Animal wastes and plants residues have high BOD
  - Chemical pesticides can leach into groundwater
- Almost all streams and rivers are polluted with agricultural pesticides

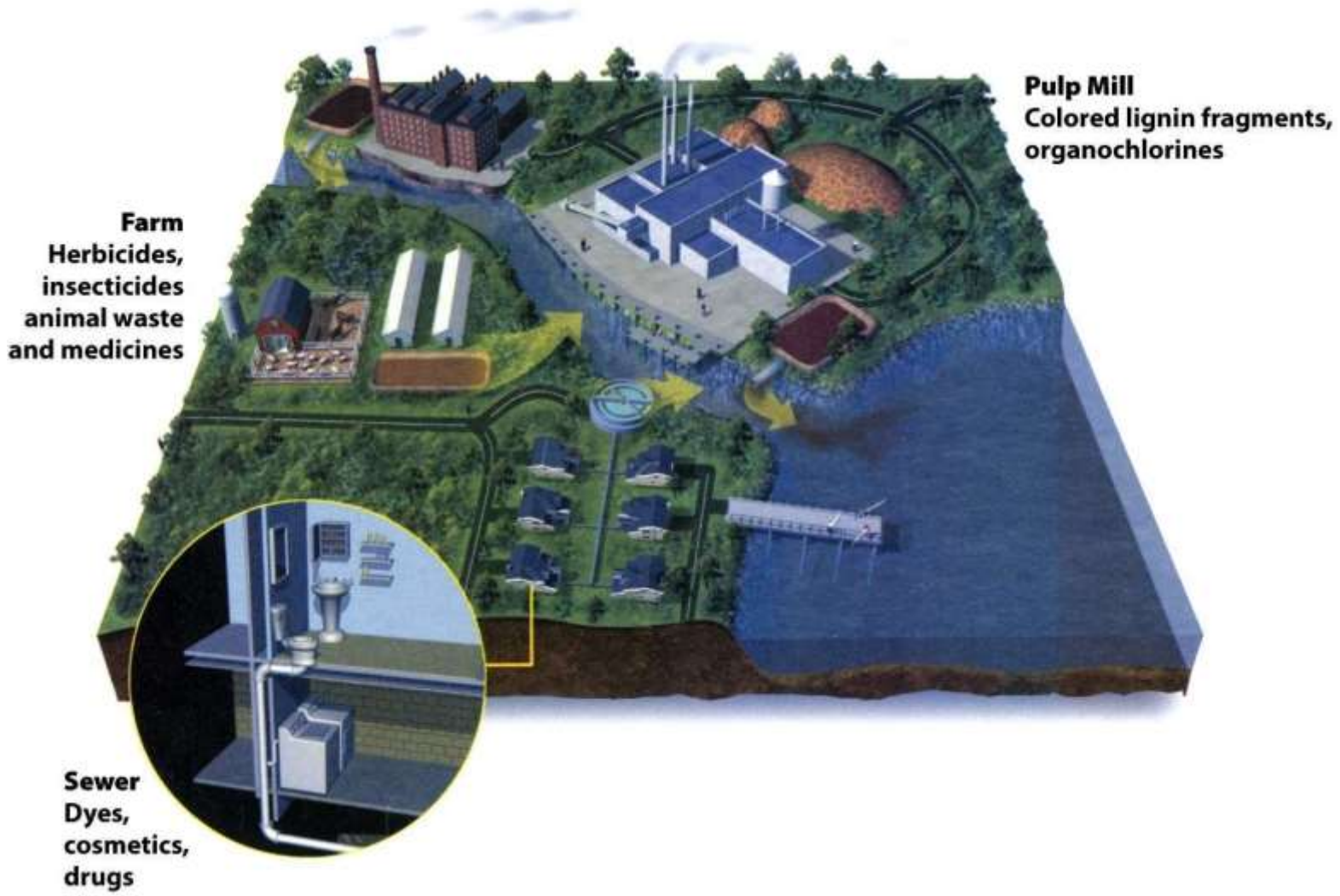
Municipal Water Pollution



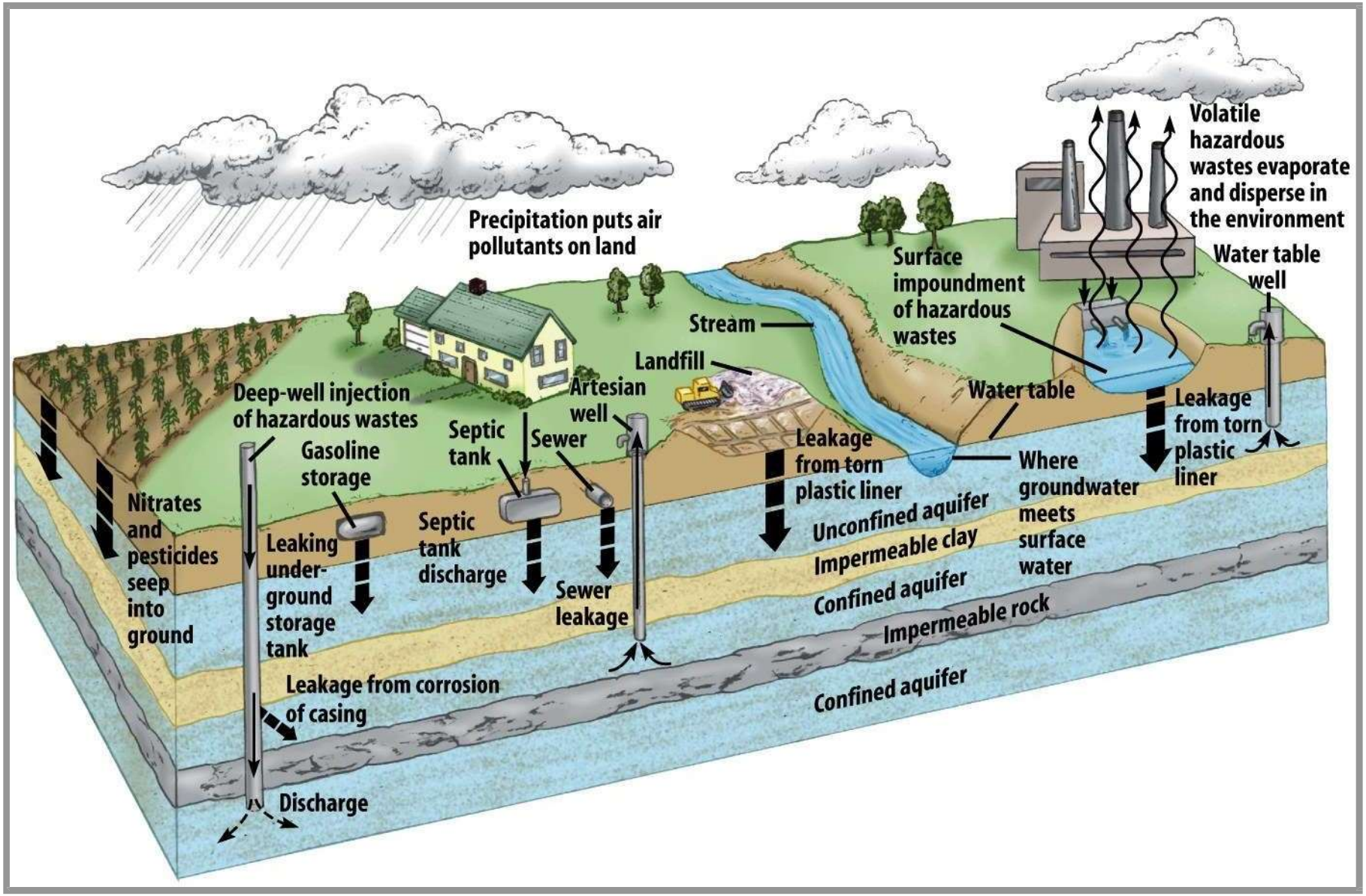
Industrial Wastes in Water

- Different industries generate different pollutants
  - Food processing plants- high BOD
  - Paper mills- High BOD and toxic compounds
- Many industries recover toxins before they go into the waste stream

Case-In-Point Green Chemistry



Groundwater Pollution



Water Pollution in India

- Ganges River
  - Used for bathing and washing clothing
  - Sewage and industrial waste discharged into river
  - Ganga Action Plan initiated by government
    - Construction of 29 sewage treatment plants

Water Pollution in Other Countries

- Lake Maracaibo, Venezuela
  - 10,000 oil wells tap lake bottom
    - Leak oil into lake

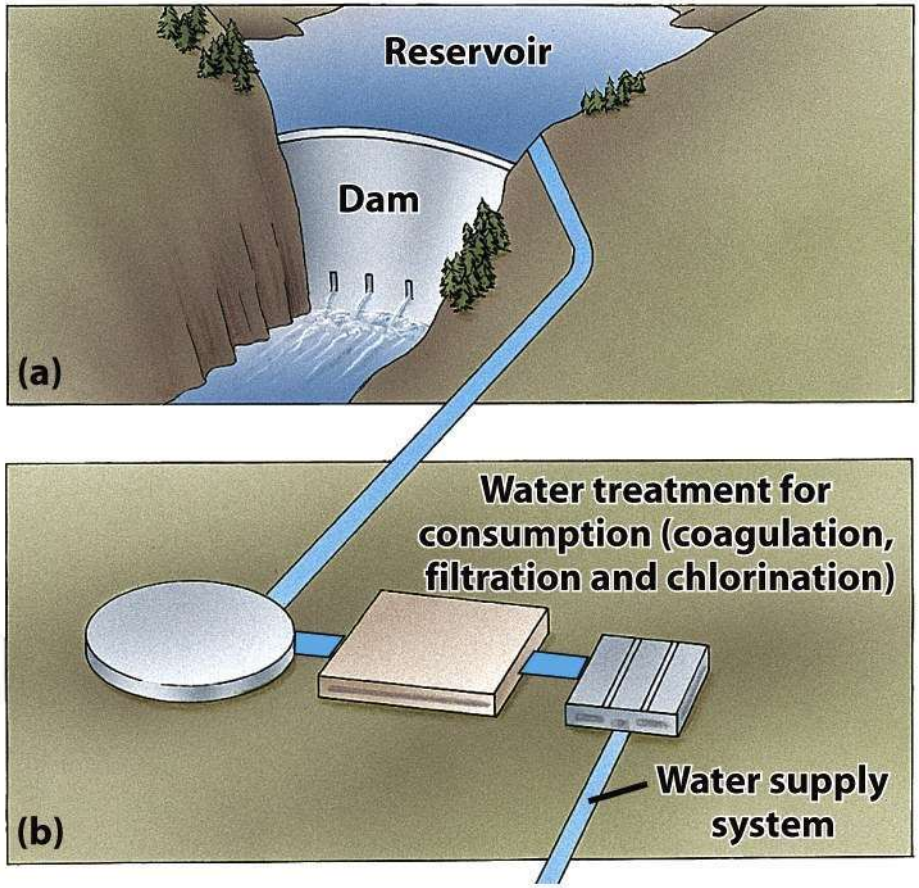
- Agricultural wastes from local fields
- Unit recently raw human waste polluted the lake

Water Pollution in Other Countries

- Po River, Italy
  - Similar to Mississippi River
  - Pollutants: Sewage, industrial wastes, sediment
  - >16 million Italians depend on the river for drinking water
  - Pollution is high
    - Swimming and fishing prohibited
  - Cleanup will require a national management plan and may take decades

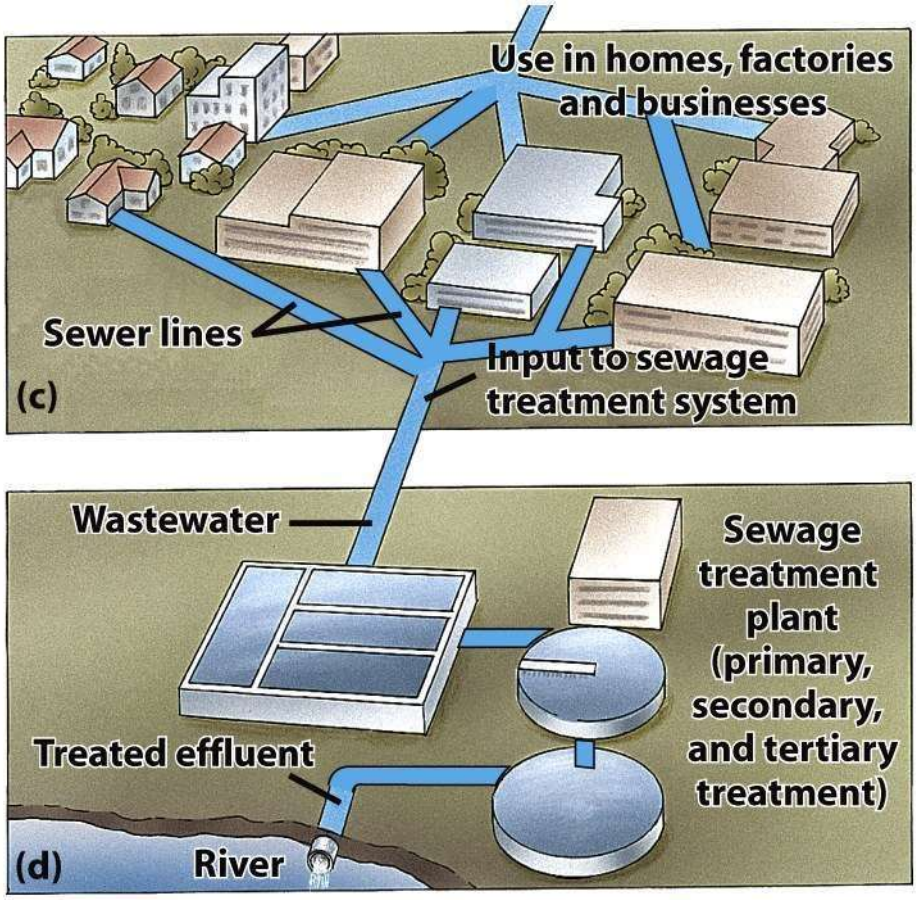
Improving Water Quality- Purification of Drinking Water

- In India most municipal water supplies are treated
- Collected from water bodies or reservoirs

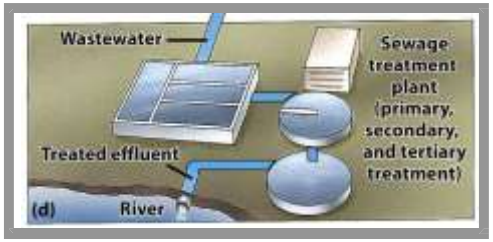


Improving Water Quality- Purification of Drinking Water

- Treated water distributed to customers
- Sewer lines bring sewage to treatment plant
- Sewage treated at sewage treatment plant



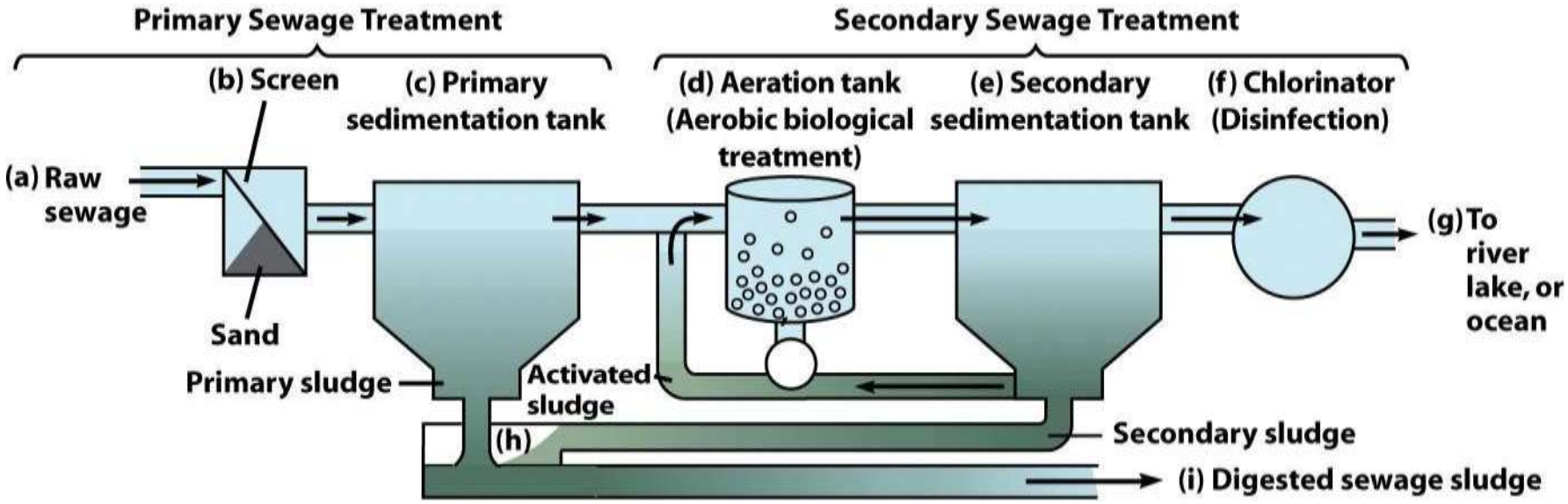
Purification of Drinking Water



- Chlorine Dilemma
  - Chlorine kills disease causing organisms
  - Chlorine byproducts are linked to numerous cancers, miscarriages and birth defects
  - Peru stopped using chlorine
    - 1991- huge cholera epidemic that infected 300,000 people
- Fluoridation
  - Prevents tooth decay
  - Linked to cancer, kidney disease

Municipal Sewage Treatment

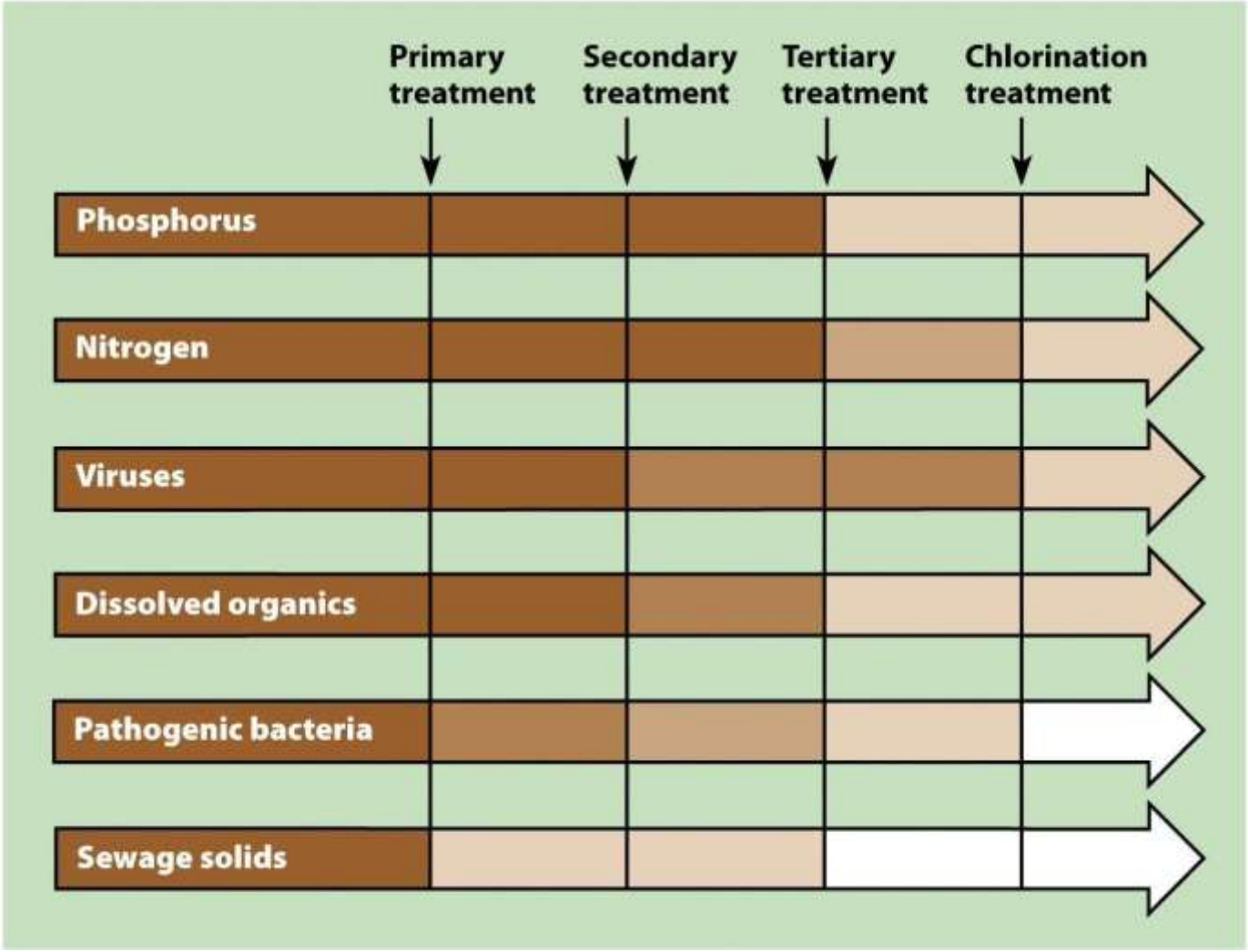
- Primary treatment
  - Removing suspended and floating particles by mechanical processes
- Secondary treatment
  - Treating wastewater biologically to decompose suspended organic material; reduces BOD



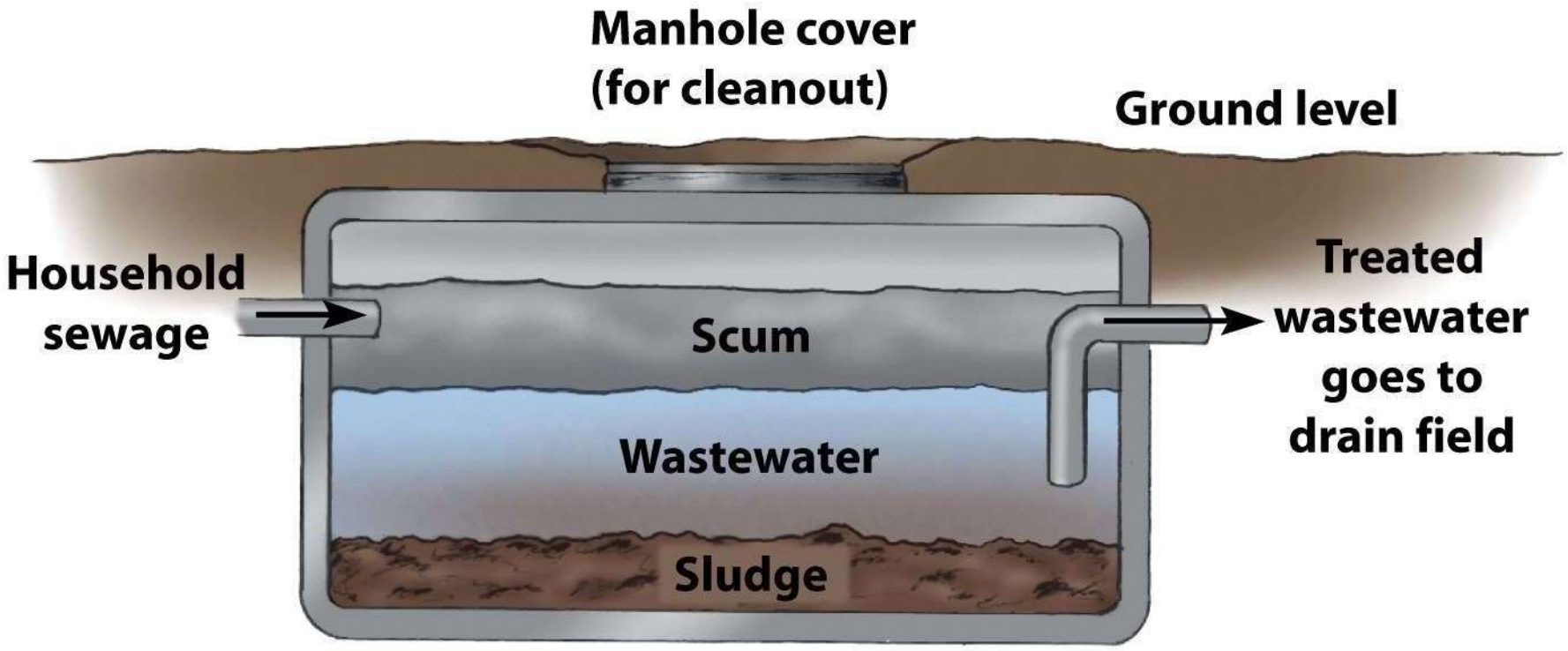
Municipal Sewage Treatment

- Sewage Sludge
  - Solids remaining after primary and secondary sewage treatment has been completed
- Tertiary treatment
  - Advanced wastewater treatment methods that are sometimes employed after primary and secondary treatments
  - Reduce phosphorus and nitrogen

Municipal Sewage Treatment



Individual Septic System-
Septic Tank



Individual Septic System-
Drain Field