CHAPTER 11 - Section 3: Water Pollution

E.Q. *What are the main types of water pollution and how are they cleaned up?*

SEV4. Students will understand and describe availability, allocation and conservation of energy and other resources.

a. Differentiate between renewable and nonrenewable resources including how different resources are produced, rates of use, renewal rates, and limitations of sources. Distinguish between natural and produced resources.

b. Describe how technology is increasing the efficiency of utilization and accessibility of resources.

c. Describe how energy and other resource utilization impact the environment and recognize that individuals as well as larger entities (businesses, governments, etc.) have impact on energy efficiency.

d. Describe the relationship of energy consumption and the living standards of societies.

e. Describe the commonly used fuels (*e.g.* fossil fuels, nuclear fuels, etc.) and some alternative fuels (*e.g.*wind, solar, ethanol, etc.) including the required technology, availability, pollution problems and implementation problems. Recognize the origin of fossil fuels and the problems associated with our dependence on this energy source.

f. Describe the need for informed decision making of resource utilization. (*i.e.* energy and water usage allocation, conservation, food and land, and long-term depletion)

What are waterborne infectious diseases?

Waterborne infectious diseases are diseases caused by a number of different bacteria, viruses, or protozoa (one-cell animals), which are spread through contaminated drinking water. Examples of these diseases include diarrheas, dysenteries, salmonellosis, hepatitis, and giardiasis. Symptoms vary, but nausea, vomiting, and diarrhea, with or without fever, are most common. It's not unusual for people to mistake a case of waterborne disease for food poisoning or a "24-hour flu bug."

OBJECTIVES

- **Water Pollution**
- **Point-Source Pollution**
- **Nonpoint-Source Pollution**
- **Point and Nonpoint Sources of Pollution**
- **Principal Water Pollutants**
- **Wastewater**
- **Treating Wastewater**
- **Wastewater Treatment Process**

- **Sewage Sludge**
- **Artificial Eutrophication**
- **Thermal Pollution**
- **Groundwater Pollution**
- **Cleaning Up Groundwater Pollution**
- **Compare point-source pollution and nonpoint-source pollution.**
- **Classify water pollutants by five types.**
- **Explain why groundwater pollution is difficult to clean.**
- **Describe the major sources of ocean pollution, and explain the effects of pollution of ecosystems.**
- **Describe six major laws designed to improve water quality in the United States.**

WATER POLLUTION

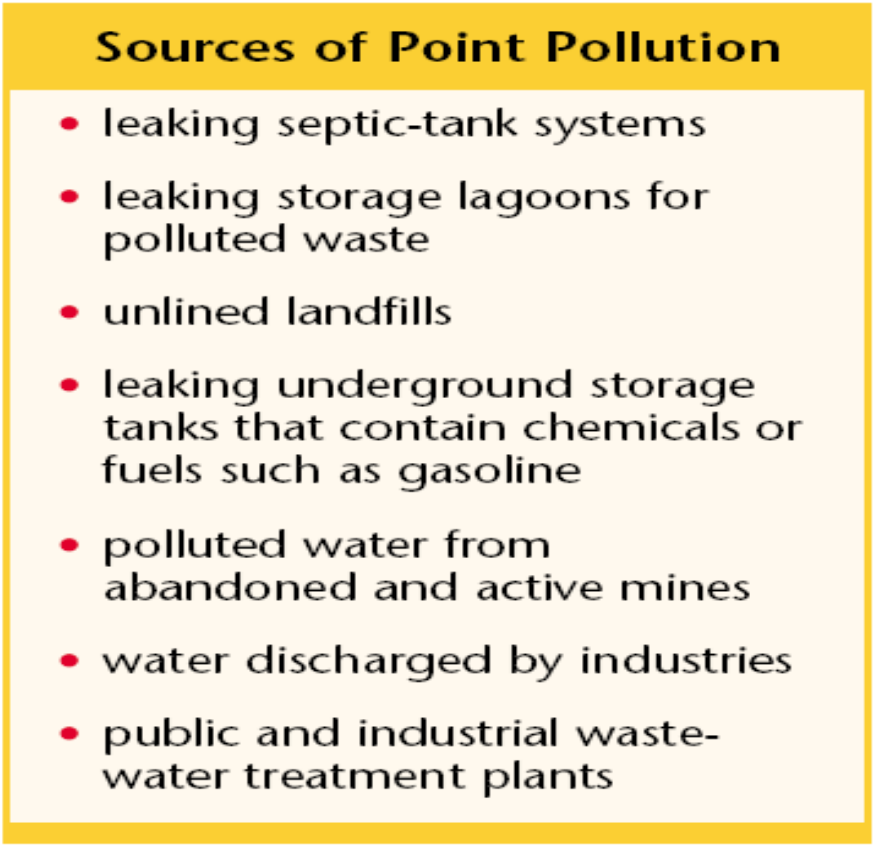
- **Water pollution is the introduction into water of waste matter or chemicals that are harmful to organisms living in the water or to those that drink or are exposed to the water.**
- **Almost all of the ways that we use water contribute to water pollution.**
- **However, the two underlying causes of water pollution are industrialization and rapid human population growth.**
- **Developed countries have made great strides in cleaning up many polluted water supplies, but some water is still dangerously polluted.**
- **In developing parts of the world, water pollution is a big problem because often the only water available for drinking in the these countries is polluted with sewage and agriculture runoff, which can spread waterborne diseases.**
- **Water pollution comes from two types of sources: point and nonpoint sources.**

POINT-SOURCE POLLUTION

- **When you think of water pollution, you probably think of a single source, such as a factory, a wastewater treatment plant, or a leaking oil tanker. These are all examples of point-source pollution.**
- **Point-source pollution is pollution that comes from a specific site.**
- **Although point-source pollution can often be identified and traced to a source, enforcing cleanup is sometimes difficult.**

NONPOINT-SOURCE POLLUTION

- **Non-point source pollution is pollution that comes from many sources rather than from a single specific site. An example is pollution that reaches a body of water from streets and storm sewers.**
- **The accumulation of small mounts of water pollution from many sources is a major pollution problem.**
- **Controlling nonpoint-source pollution depends to a great extent on public awareness of the effects of activities such as spraying lawn chemicals.**



Nonpoint Sources of Pollution

- chemicals added to road surfaces (salt and other de-icing agents)
- water runoff from city and suburban streets that may contain oil, gasoline, animal feces, and litter
- pesticides, herbicides, and fertilizer from residential lawns, golf courses, and farmland
- feces and agricultural chemicals from livestock feedlots
- precipitation containing air pollutants
- soil runoff from farms and construction sites
- oil and gasoline from personal watercraft

PRINCIPAL WATER POLLUTANTS

Pollutant Types and Sources

Type of pollutant	Agent	Major sources
Pathogens	disease-causing organisms, such as bacteria, viruses, protozoa, and parasitic worms	mostly nonpoint sources; sewage or animal feces, livestock feedlots, and poultry farms; sewage from overburdened wastewater treatment plants
Organic matter	animal and plant matter remains, feces, food waste, and debris from food-processing plants	mostly nonpoint sources
Organic chemicals	pesticides, fertilizers, plastics, detergents, gasoline and oil, and other materials made from petroleum	mostly nonpoint sources; farms, lawns, golf courses, roads, wastewater, unlined landfills, and leaking underground storage tanks
Inorganic chemicals	acids, bases, salts, and industrial chemicals	point sources and nonpoint sources; industrial waste, road surfaces, wastewater, and polluted precipitation
Heavy metals	lead, mercury, cadmium, and arsenic	point sources and nonpoint sources; industrial discharge, unlined landfills, some household chemicals, and mining processes; heavy metals also occur naturally in some groundwater
Physical agents	heat and suspended solids	point sources and nonpoint sources; heat from industrial processes and suspended solids from soil erosion

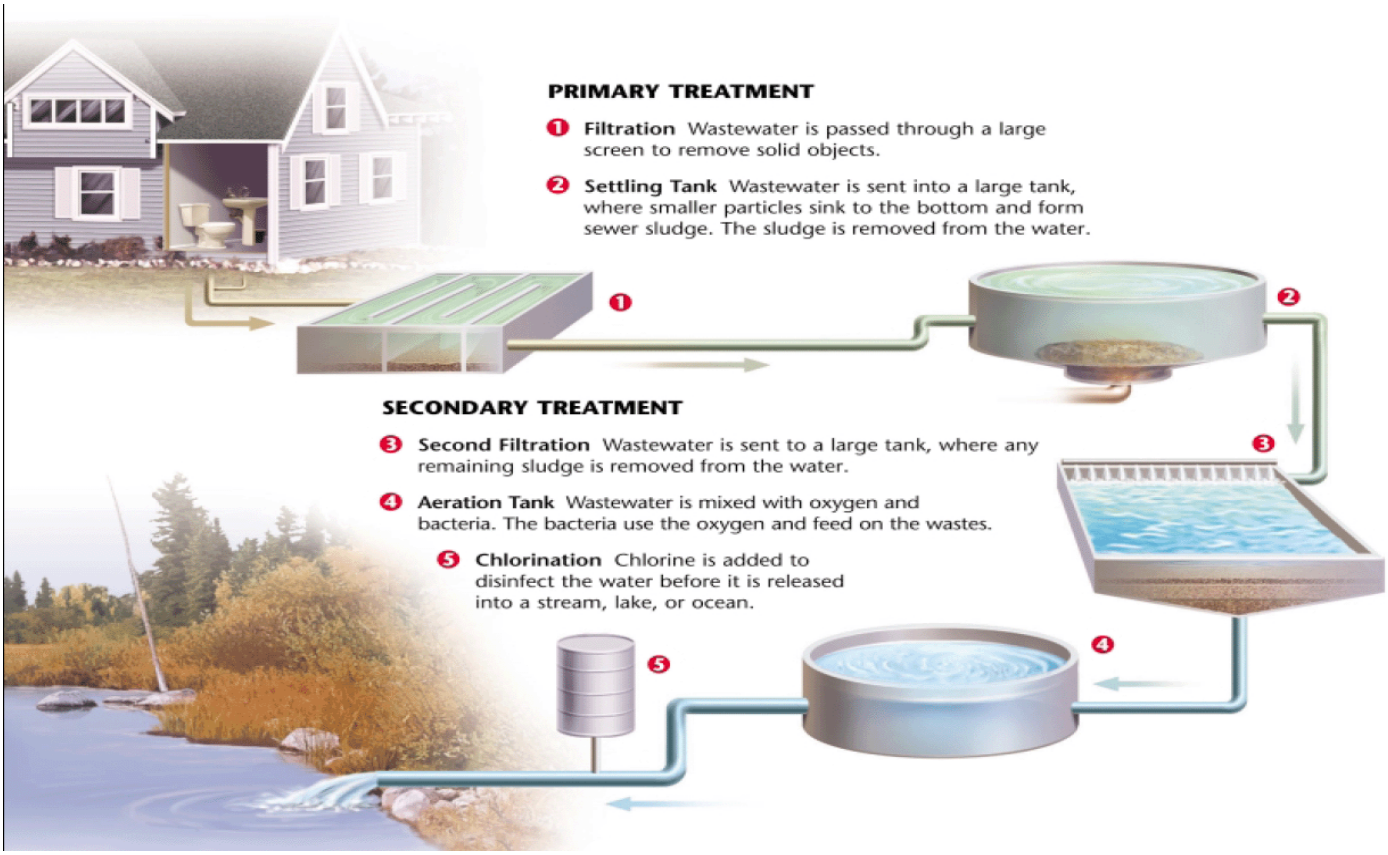
WASTEWATER

- **After water flows down the drain in the sink, it usually flows through a series of sewage pipes that carry it, along with all the other wastewater in your community, to a wastewater treatment plant.**
- **Wastewater is water that contains wastes from homes or industry.**
- **At a wastewater treatment plant, water is filtered and treated to make the water clean enough to return to a river or lake.**

TREATING WASTEWATER

- **Most of the wastewater from homes contains biodegradable material that can be broken down by living organisms.**
- **For example, wastewater from toilets and kitchen sinks contains animal and plant wastes, paper, and soap, all of which are biodegradable.**
- **But, some household and industrial water and some storm-water runoff contains toxic substances that cannot be removed by the standard treatment.**

WASTEWATER TREATMENT PROCESS



SEWAGE SLUDGE

- **One of the products of wastewater treatment is sewage sludge, the solid material that remains after treatment.**
- **When sludge contains dangerous concentrations of toxic chemicals, it must be disposed of as hazardous waste. It is often incinerated, and then the ash is buried in a secure landfill.**
- **Sludge can be an expensive burden to cities as the volume of sludge that has to be disposed of every year is enormous.**
- **The problem of sewage sludge disposal has prompted many communities to look for new uses for this waste.**
- **If the toxicity of sludge can be reduced to safe levels, it can be used as a fertilizer.**
- **In another process, sludge is combined with clay to make bricks that can be used in buildings.**

ARTIFICIAL EUTROPHICATION

- **Most nutrients in water come from organic matter, such as leaves and animal waste, that is broken down into mineral nutrients by decomposers such as bacteria and fungi.**
- **Nutrients are an essential part of any aquatic ecosystem, but when lakes and slow-moving streams contain an abundance of nutrients, they are eutrophic.**

- **Eutrophication is a natural process**
- **When organic matter builds up in a body of water, it will begin to decay and decompose. The process of decomposition uses up oxygen, and as oxygen levels decrease, the types of organisms that live in the water change over time.**
- **For example, plants take root in the nutrient rich soil, and as more plants grow,the shallow waters begin to fill in. Eventually the body of water becomes a swamp or marsh.**
- **The natural process of eutrophication is accelerated when inorganic plant nutrients, such as phosphorus and nitrogen, enter the water from sewage and fertilizer runoff.**
- **Artificial eutrophication is a process that increases the amount of nutrients in a body of water through human activities, such as waste disposal and land drainage.**
- **The major causes of eutrophication are fertilizer and phosphates in some laundry detergents.**
- **Phosphorus is a plant nutrient that can cause the excessive growth of algae.**
- **In bodies of water polluted by phosphorus, algae can form large floating mats, called algal blooms.**
- **As the algae die and decompose, most of the dissolved oxygen is used and fish and other organisms suffocate in the oxygen-depleted water.**

<u>THERMAL POLLUTION</u>

- **Thermal pollution is a temperature increase in a body of water that is caused by human activity and that has harmful effect on water quality and on the ability of that body of water to support life.**
- **Thermal pollution can occur when power plants and other industries use water in their cooling systems and then discharge the warm water into a lake or river.**
- **Thermal pollution can cause large fish kills if the discharged water is too warm for the fish to survive.**
- **If the temperature of a body of water rises even a few degrees, the amount of oxygen the water can hold decreases significantly. As oxygen levels drop, aquatic organisms may suffocate and die.**
- **If the flow of warm water into a lake or stream is constant, it may cause the total disruption of an aquatic ecosystem.**

<u>GROUNDWATER POLLUTION</u>

- **Pollutants usually enter groundwater when polluted surface water percolates down from the Earth's surface.**
- **Any pollution of the surface water in an area can affect the groundwater.**
- **Pesticides, herbicides, chemical fertilizer, and petroleum products are common groundwater pollutants. Other sources of pollution include septic tanks, unlined landfills, and industrial wastewater lagoons.**
- **Leaking underground storage tanks are another major source of groundwater pollution because as they age, they may develop leaks that allow pollutants to seep in to the groundwater.**
- **Leaking tanks often cannot be repaired or replaced until after they have leaked enough pollutants to be located.**
- **Modern storage tanks are contained in concrete and have many other features to prevent leaks.**
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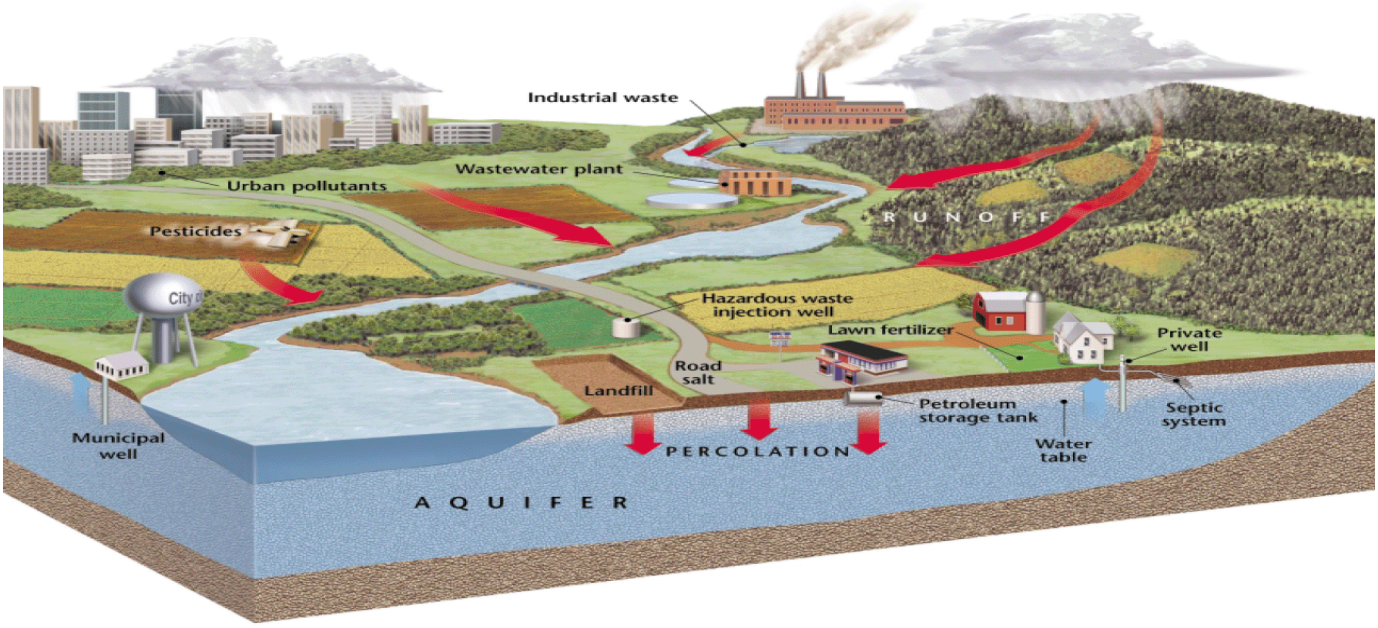
Groundwater Pollution Diagram



CLEANING UP GROUNDWATER POLLUTION

- **Groundwater pollution is one of the most challenging environmental problems in the world.**
- **Groundwater recharges very slowly, so the process for some aquifers to recycle water and purge contaminants can take hundreds of years.**
- **Also, pollution can cling to the materials that make up an aquifer, so even if all of the water in aquifer were pumped out and replaced with clean water, the groundwater could still become polluted.**

OCEAN POLLUTION

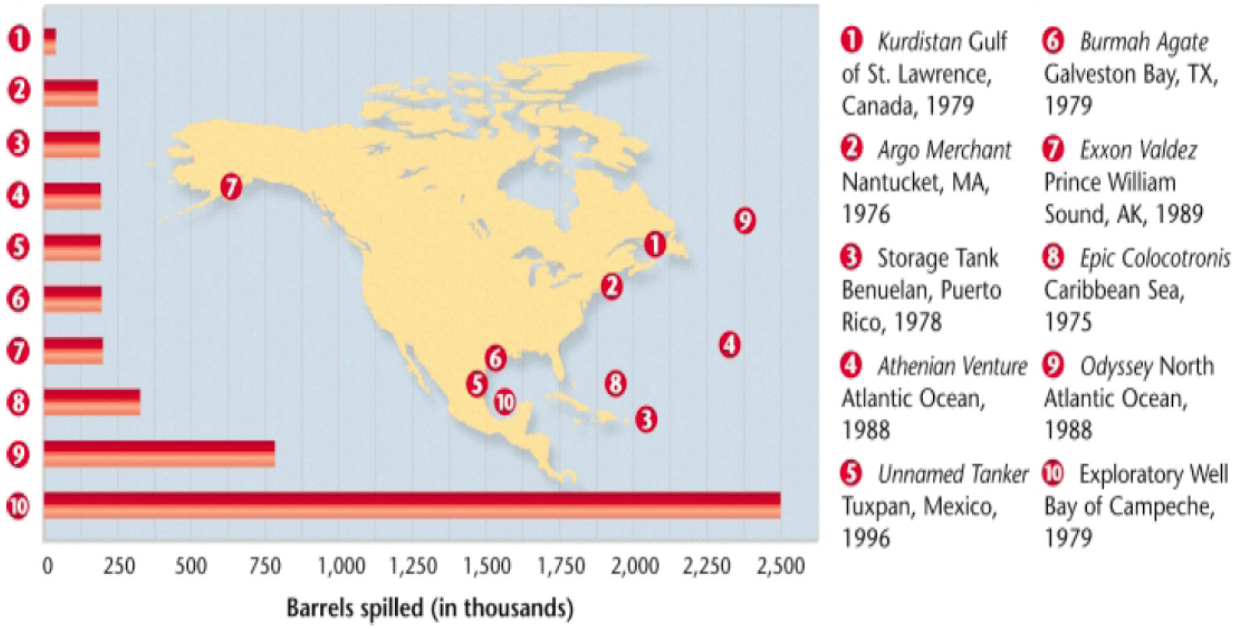
- **Pollutants are often dumped directly into the ocean. For example, ships can legally dump wastewater and garbage overboard in some parts of the ocean.**
- **But at least 85 percent of ocean pollution, including pollutants such as oil, toxic wastes, and medical wastes, comes from activities on land, near the coasts.**
- **Sensitive coastal ecosystems, such as coral reefs, are the most effected by pollution.**

OIL SPILLS

- **Ocean water is also polluted by accidental oil spills. Each year, about 37 million gallons of oil from tanker accidents are spilled into the ocean.**
- **Such oil spills have dramatic effects, but they are responsible for only about 5 percent of oil pollution in the oceans. Most of the oil that pollutes the oceans comes from cities and towns.**
- **Limiting these nonpoint-sources of pollution would go a long way toward keeping the oceans clean.**

On April 20, 2010, an explosion occurred on the semi-submersible offshore drilling rig Deepwater Horizon in the Gulf of Mexico, killing 11 rig workers and injuring 17 others. On April 24, it was found that the wellhead was damaged and leaking oil into the Gulf. The spill poses a serious threat to all wildlife affecting as many as 400 species along the coastal areas of Louisiana, Mississippi, Alabama, and Florida. The oil spill was not contained until July 15 when it was estimated that 4.9 million barrels or 205.8 million gallons of crude oil spilled into the Gulf making it one of the largest oil spills of all time. BY GOOGLE CRISIS RESPONSE

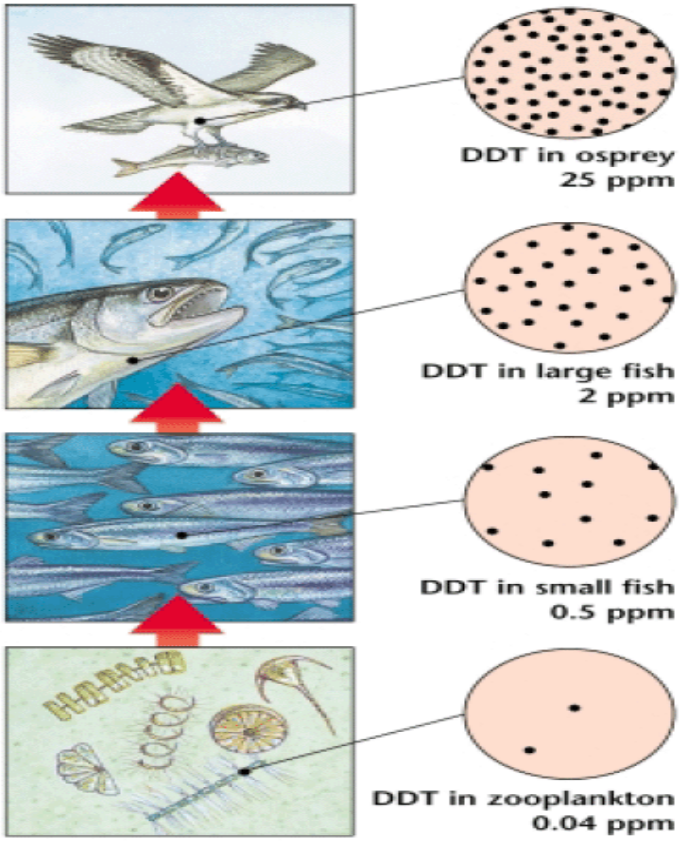
OIL SPILLS



WATER POLLUTION & ECOSYSTEMS

- **Water pollution can cause immediate damage to an ecosystem, but the effects can be far reaching as some pollutants build up in the environment because they do not decompose quickly.**
- **Biomagnification is the accumulation of pollutants at successive levels of the food chain.**
- **Biomagnification has alarming consequences for organisms at the top of the food chain, and is one reason why U.S. states limit the amount of fish people can eat from certain bodies of water.**

Water Pollution and Ecosystems



CLEANING UP WATER POLLUTION

- **The Clean Water Act of 1972 was to designed to "restore and maintain the chemical, physical, and biological integrity of the nation's waters."**
- **The goal of making all all surface water clean enough for fishing and swimming by 1983 was never achieved, but much progress has been made since the act was passed.**
- **The percentage of lakes that are fit for swimming has increased by 30 percent, and many states have passed stricter water-quality standards.**
- **The Clean Water Act opened the door for other water-quality legislation.**
- **For example, the Marine, Protection, Research, and Sanctuaries Act of 1972 strengthened the laws against ocean dumping.**
- **Also, the Oil Pollution Act of 1990 requires all oil tankers traveling in U.S. waters to have double hulls by 2015 as an added protection against oil spills**

CLEANING UP WATER POLLUTION

Federal Laws Designed to Improve Water Quality in the United States
1972 Clean Water Act (CWA) The CWA set a national goal of making all natural surface water fit for fishing and swimming by 1983 and banned pollutant discharge into surface water after 1985. The act also required that metals be removed from wastewater.
1972 Marine Protection, Research, and Sanctuaries Act, amended 1988 This act empowered the EPA to control the dumping of sewage wastes and toxic chemicals in U.S. waters.
1975 Safe Drinking Water Act (SDWA), amended 1996 This act introduced programs to protect groundwater and surface water from pollution. The act emphasized sound science and risk-based standards for water quality. The act also empowered communities in the protection of source water, strengthened public right-to-know laws, and provided water system infrastructure assistance.
1980 Comprehensive Environmental Response Compensation and Liability Act (CERCLA) This act is also known as the Superfund Act. The act makes owners, operators, and customers of hazardous waste sites responsible for the cleanup of the sites. The act has reduced the pollution of groundwater by toxic substances leached from hazardous waste dumps.
1987 Water Quality Act This act was written to support state and local efforts to clean polluted runoff. It also established loan funds to pay for new wastewater treatment plants and created programs to protect major estuaries.
1990 Oil Pollution Act This act attempts to protect U.S. waterways from oil pollution by requiring that oil tankers in U.S. waters be double-hulled by 2015.

Quick LAB

QuickLAB

Measuring Dissolved Oxygen

Procedure

1. Start with **three water samples**, each in a **plastic jar** that is ¾ full. Two water samples should be tap water from a faucet without an aerator. One sample should be water that has been boiled and allowed to cool.
2. Using a **dissolved-oxygen test kit**, test the boiled water and one other water sample.
3. Tighten the lid on the third sample, and then vigorously shake the sample for one minute. Unscrew the lid, and then recap the jar.
4. Repeat step 3 twice. Then, uncap the jar quickly, and test the sample.

Analysis

1. Which sample had the highest dissolved oxygen level? Which sample had the lowest level?
2. What effects do rapids and waterfalls have on the levels of dissolved oxygen in a stream? What effect does thermal pollution have?

MATHPRACTICE

Parts per Million Water contamination is often measured in parts per million (ppm). If the concentration of a pollutant is 5 ppm, there are 5 parts of the pollutant in 1 million parts of water. If the concentration of gasoline is 3 ppm in 650,000 L of water, how many liters of gasoline are in the water?